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PHYSIOGRAPHY AND GEOLOGY OF SAMAR ISLAND, PHILIPPINE ISLANDS

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FIVE PLATES AND THREE TEXT FIGURES

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INTRODUCTION

It was in 1521 that the navigator Magellan sighted a "rough, mountainous island called by the natives Zamal" and his findings were recorded. From time to time, since his day Samar has been lifted out of its obscurity by historical events or because of the occurrence of an earthquake or a typhoon of more than ordinary severity. For the most part, however, scientists seem to have passed the island by, rich though the field may prove

to be. There are scattered brief accounts of the natural history of the island. Jagor, a German scientist, spent some time on Samar, and his two chapters relating to the island represent the nearest approach to anything accurate that has been produced. No geologic survey was ever made of this country until our party made its general reconnaissance during November and December, 1920. The purpose of this paper is to present the results of that exploration.

SUMMARY

These observations and conclusions are offered as contributions to science rather than as direct aids to the economic geologist, since it was found that Samar is far from being a rich mineralogic province. Gradation, aided by diastrophism, has so well dismembered the strata that there now exists no definite cordillera; instead, there are short mountain ranges, many streams, and no great elevations and, consequently, no sharp differentiation between the wet and the dry seasons. Physiography has strongly influenced the economic development of the island and has had a marked effect on the social development of its inhabitants. The rocks are principally sedimentary ones deposited in the shallow waters bordering an island which, in its early history, had an igneous core. As time went on, many changes of level took place until in fairly recent times comparatively flat beds of marl, shale, and sandstone were deposited and the present land forms carved out. It is unlikely that Samar will become a center of mineral production, for industrially important minerals are apparently entirely lacking or of inferior quality.

GENERAL STATEMENTS

LOCATION

Samar Island is that member of the Visayan group of islands of the Philippine Archipelago which is immediately southeast of Luzon Island, and north and east of Leyte Island. It lies between 11° 01′ and 12° 36′ north latitude, and 124° 15′ and 125° 46′ east longitude. Between Samar and Luzon is San Bernardino Strait, while the narrow, tortuous San Juanico Strait separates Leyte from Samar. Catbalogan, the capital, is, on a direct line, 525 kilometers southeast of Manila.

SHAPE AND AREA

Samar may be considered as a large trapezium, the longer sides running northwest and southeast and the shorter sides bearing approximately east and west. Considering this geo-

metric form, we find that the southern side, Basey to Guiwan, measures roughly 80 kilometers; the northern coast from Balicuatro Point to Cape Espiritu Santo, 100 kilometers; the east coast from Cape Espiritu Santo to Guiwan, 185 kilometers. The fourth, the west-coast side, extends from Balicuatro Point to Basey, a distance of 170 kilometers. Its entire area is about 12,000 square kilometers.

COAST

There is no open port of entry in Samar,[1] and most of the business is carried on through Manila. Interisland boats usually touch only at Catbalogan and Calbayog, both open roadsteads. On the east coast there is no good port for vessels of any size, and on the entire island only one port ranks as high as class 2.

ROADS

According to the Director of Public Works, the roads in Samar Province, as of June 30, 1920, are as follows:

	Km.
First-class roads	103.4
Second-class roads	44.7
Third-class roads	91.2
Total	239.3

Road construction on the island is difficult, owing to the type of topography, the climate, the geology, the lack of funds, and other factors. The only roads available for use by automobiles are short stretches along the north, east, and west coasts. There is no complete cross-island road, although one is projected from Wright to Taft, through a natural pass.

MAPS

One of the two most accurate maps of Samar Island, Bureau of Public Works map bearing the date 1920, was prepared under the direction of the district engineer of Samar, Mr. Ralph Frush. This map gives the correct location, as far as known, of towns, streams, and other features. The Coast and Geodetic Survey map of 1920 (No. 13) is excellent and is the only one that gives a good suggestion of the topography. Many maps of the island are so inaccurate as to lead one to the conclusion that it is dotted with towns and villages, which is certainly far from being the case.

[1] Coast and Geodetic Survey charts Nos. 4715, 4719. Hydrograhpic Office charts Nos. 2049, 1729, 1730. See Bull. C. and G. S. Sec. IV, P. I. Sailing Regulations.

CULTIVATED AREAS

The Philippine Census of 1918 gives the area of farms in Samar Province as 177,357 hectares; that is to say, approximately 13 per cent of the total area of the island is under cultivation. The cultivated tracts of land lie principally along the coasts. There are rich farms in the valleys of Catubig, Gandara, Catarman, Dolores, Ulot, Calbiga, and Basey Rivers; but little of the land in the interior is devoted to agriculture. Some of the rich uncultivated districts on the island could be developed to produce more rice, copra, and abacá, the principal agricultural products at present grown. Agricultural development apparently is hindered by poor means of communication and insufficient population. The population, by the enumeration of 1918, was stated as being 362,399.

CLIMATE

The wet and the dry seasons on Samar are not so sharply defined as they are on some of the other islands of the Archipelago. Those planning to go into this country are strongly advised not to attempt field trips during November, December, and January especially, for the heaviest rains occur then. Typhoons usually are most violent during September and October. The climate, however, throughout the year is cool and healthful and, on the whole, more pleasant than that of Manila.

FIELD WORK

The chief of our party was Graham B. Moody, who was engaged in economic work. I was detailed by the Bureau of Science to coöperate with him. Distance, or time, traverses were made wherever possible, directions being obtained by a Brunton compass, and elevations by an aneroid barometer. The time spent in the field extended from October 30 to December 7, 1920, during which period the following itinerary (see Plate 4) was followed:

Catbalogan to Calbayog, thence up Gandara River to Matuguinao, and returning to Catbalogan. From there, we proceeded to Wright and Loquilocan, Concord (Bagakay), and Taft.

From Taft the route followed was to Maslog, on Dolores River; by trail to Concepcion, Jipapad, and San Vicente, and from the latter place by boat down Catubig River to the town of Catubig and on to Laoang, thence along the north coast to Catarman and Carangian, where the party boarded a launch for Basey.

The final stage of the trip was from Basey to Calbiga, thence to Wright, and finally back to Catbalogan.

ACKNOWLEDGMENTS

I am particularly indebted to Mr. Moody for assistance rendered by him in the field, for his aid in the interpretation of the data obtained, for his criticism of the manuscript, and for other important details.

Dr. Warren D. Smith assisted me in the determination of the rocks and verified the classification that appears herein. He made many valuable suggestions, and I am deeply indebted to him for this aid.

Dr. Roy E. Dickerson, of the Richmond Petroleum Company, has carefully criticised the paper, made fossil determinations, and otherwise assisted me in the preparation of the paper. I desire to express my sincere gratitude for this.

Fr. M. Saderra Masó, S. J., of the Weather Bureau in Manila, outlined some of the climatic conditions to me and supplied me with the note on recent earthquakes which forms a portion of this account.

Prof. Frank G. Haughwout encouraged me by his never-failing interest in my work.

The list of acknowledgments would be incomplete if I made no mention of the various Americans on Samar Island, particularly Messrs. Frush, Shawger, and Ryans, who rendered valuable assistance to the party during its reconnaissance. Their coöperation and interest made the work easier and more agreeable than it otherwise might have been.

PHYSIOGRAPHY

The name Samar perhaps is derived from the Visayan word *samad*, meaning "wounded," or "cut up." Although it cannot be said that the original namers of the island had physiographic peculiarities in mind, nevertheless, this definition well describes the island's topography. Physiography has been, and still is, an important factor in the development of the province, and it is partly for this reason that more than passing attention is given the subject.

RELIEF AND DRAINAGE

As one approaches Samar from the west, he notices that the skyline of the island is more or less regular, though slightly serrate, suggesting peneplanation or perhaps widespread terracing. Numerous small islands lie off the coast. A closer view

of the island near Catbalogan shows the topography to be mature, and a more extended survey proves that the island, as a whole, is maturely dissected, although the area in the northwest corner is more youthful. Relatively speaking, the relief of the island is low, for there is no peak higher than 1,000 meters, and there are no prominent ones such as are to be seen on Leyte.

The arrangement of the rivers and their branches in Samar is more or less dendritic, as the accompanying map (Plate 5) will show. The island is drained by streams that meander to a very great degree. Some of these streams appear to be in the second cycle of erosion, typically in the region between Buau and Matuguinao. Rivers are more abundant and longer on the east than on the west coast; and in places those of the Pacific side appear to be drowned (near Taft), while on the west coast there are evidences of uplift.[2] The swamps at the mouths of the rivers are due, therefore, to uplift and a ponding of the water, and are not the result of subsidence and overflow alone. The headwaters of the streams are rocky and in many cases dangerous. Ulot River is probably an antecedent stream that rises remarkably near the west coast, and upon nearing the ocean appears to be controlled by an uplifted marine terrace (see fig. 3).

NATURE OF THE TOPOGRAPHY

Since the topography of Samar is mature, the area of undissected surface is not great. The valleys that now exist are due, for the greater part, to erosion of nearly flat beds of soft material. This cutting action has been aided by uplift and local folding and faulting. In most cases the valleys are not wide, but they are numerous; it is probable that some of them are structural. For example, near the barrio of Jipapad on the Jipapad-San Vicente trail there are two small valleys which appear to be fault valleys. The soils of the valleys are usually clayey, though in places they contain some sand.

Marine terracing is inferred from certain features, as will be pointed out, and future work probably will show that these features have markedly affected the topography of the country. From present information, it may be stated that the high peaks of Samar have a general northwest and southeast trend; that is to say, they follow the general direction of the island.

[2] Recent uplift at Basey was reported by Jagor in his "Journeys" and was noted at Wright, Calbiga, and other localities by our party.

Attention should be called to the rough topography in the limestone districts, such as at Matuguinao, where there are great caverns, sinks, and subterranean streams. The caving of these sinks results in the formation of coves and, later, valleys. Mention has been made elsewhere of islands that have been formed from blocks of limestone cut off from the parent mass.

When one considers the causes for the nature of the topography, one sees that the stage of maturity has resulted from variation in the hardness of the rocks, differential crustal movements, and erosion due to excessive rainfall.

OUTCROPS AND TOPOGRAPHY

Along the west coast of Samar, principally south of Calbayog, the shale hills with their inland dip and steep seaward escarpment furnish abundant outcrops, and at low tide harder beds are exposed. The topography here is that of shale hills resulting from minor folding, minor and major faulting, and tropical erosion.

Good outcrops in the beds of creeks can be seen on the north coast, where durable sandstones and a well-cemented conglomerate, especially near the Catarman Agricultural School, give a prominent, but not high, coastal ridge. The northwest corner of the island is composed in part of hills of basalt now in erosional youth.

On the south coast the best exposures are along the seashore. They consist of massive limestone masses, which are being undercut by wave action. Near the sitio of Hilabá, municipality of Basey, a series of hat-shaped islands has resulted from this undercutting. Near the town of Basey, opposite Tacloban, Leyte, is a prominent shale and sandstone hill, overlain by what may be a river conglomerate.

On the eastern side of the island the low hills lying inland from the coastal plain are chiefly composed of soft sandstone, marl, and a lignitic clay, which have been exposed by the cutting action of the streams. On the left (north) bank of Malinao (Tubig) River, opposite the barrio of Taft, is a faceted spur of massive, bluish marl. There is a narrow coastal plain in this region, and coral reefs occur offshore.

The outcrops in the interior of Samar seen by our party were found chiefly in creek beds, and they consisted of flat, sandy shale (marl), clay, limestone, some andesite and basalt, and on Ulot River east of Loquilocan a hard plagioclase porphyry. As

has been stated, the valleys vary from youthful in the igneous areas to mature in areas of less-resistant rocks.

Vegetation, with its subduing effect, conceals the rocks more or less, and the shape of the outcrops cannot be determined. It seems definite, however, that the larger masses of limestone are in the interior and southern sections of Samar; that most of the igneous formations are in the center of the island and at the northwestern corner; that shales and marls, more or less flat, are common; and that the general strike of the peaks is slightly west of north.

PHYSIOGRAPHY AND CLIMATE

The rainfall is somewhat heavier on the east coast of Samar than elsewhere on the island, the annual fall there being more than 3,500 millimeters. This precipitation is exceeded only by the rainfall in the Benguet district, and at Iba, Zambales. The mean annual rainfall for the entire province is slightly more than 3,200 millimeters, with about 1,900 millimeters between November and February. Therefore, of all the provinces and subprovinces in the Archipelago, Samar ranks third in the amount of rainfall.[3]

Since there is no marked dry season on this island, erosion is taking place all the time and is checked only by the vegetation. The result on the topography of Samar as a whole is such that it is difficult to say whether or not a central cordillera exists. It is my opinion that there is no marked "backbone." Instead, erosion (and one must not forget wave action) due to great amounts of rain, together with structural features, has cut the mountains, which formerly were more continuous, into ridges and hills. There is no great difference between the amount of rainfall on the east and west coasts. This is in marked contrast to the other large islands of the Archipelago, especially those that have a definite cordillera, and this fact, alone, seems to indicate the nonexistence of a central mountain system that would act as a barrier to rain-laden winds. The only area of more-marked difference in the amount of rainfall is a small district around Calbayog, where the annual average is less than 2,500 millimeters, while Catbalogan, about 38 kilometers southeast, has a much greater average. This is perhaps explained by the fact that the igneous area and the higher peaks near Calbayog protect the city from the northeast monsoons. It can

[3] Coronas, Rev. José, S. J., The climate and weather of the Philippines, 1903 to 1918, Census of the Philippine Islands 1 (1918) 342–403.

be seen, therefore, that even to-day climate is playing an important part in the erosion of Samar.

Another physiographic feature due to this excessive precipitation is the coastal plain on the east coast. It has been noted that the rainfall there is slightly in excess of that on the west coast; consequently, more sediment is carried down by the rivers, thereby making the plains wider. The excess of rainfall on the east side of the island is due to the fact that the water-laden winds from the Pacific meet Samar as first land, so that these winds lose most of their moisture there; but, unlike Luzon, the northeasterly winds carry much rain to the west coast.

The temperature of Samar, as recorded at stations situated near the sea, has an annual normal of about 26.5° C. or about 0.4° C. below the mean annual temperature of the entire Archipelago.[4] The relation between temperature and ocean currents and rains is far closer than that between temperature and physiography. The same probably holds true with respect to cloudiness and relative humidity. I noticed little difference between the temperature in the interior and that along the coast, although places at elevations of more than 200 meters were reached. The diurnal variation was most noticeable at Matuguinao.

Physiography, rainfall, and typhoons are interrelated. A large proportion of the typhoons of moderate to destructive severity that cross the Philippines pass over Samar, and my observations there incline me strongly to the belief that typhoons aid erosion to no small degree.

A review of the relations between physiography and climate indicates that on Samar, at least, topography is the resultant of climate, and that climate does not entirely depend upon topography, although the two are closely related. Corrosion and corrasion of this island proceed at a maximum rate because of the wide distribution of heavy rainfall.

PHYSIOGRAPHY AND VEGETATION

Persons journeying across Samar Island are seldom able to see the country lying before them—a vista shows only another wooded hill ahead. As a matter of fact, this seems to hold true for the entire island except, perhaps, in the shale hills, where the vegetation is either secondary or less dense, or where deforestation has taken place. The trees are smaller on the

[4] Coronas, Rev. José, S. J., op. cit. 296–341.

northern and eastern coasts[5] where the winds are strong. The northwest corner is perhaps the most heavily forested area. There are found the large toog, mayapis, lauan, apitong, and other species, although the shale hills also support some of these large trees. As in other islands, the limestone districts are heavily forested. Merrill[6] reports various plants from Catubig River; but, although some of the plants come from as far inland as the towns of Tagabiran and Las Navas, none of the specimens occur at elevations of more than 300 meters. Nipa and mangrove swamps are abundant, the largest being at the mouth of Gandara River. Vegetation is luxuriant on Samar and has effectively concealed much of the geology of the island.

PHYSIOGRAPHIC INFLUENCES

It has been said often that Samar is one of the most undesirable islands in the Archipelago, as regards its inhabitants and the character of the country. Of interest and value, therefore, might be a brief account of how topography has actually affected the development of the people. The principal effects, I believe, have been upon land communications, transportation by water, agriculture, and the temperament of the people.

First.—The population centers chiefly along the coasts where communication is easier, although even this is not too simple, since there are many rivers to cross. In the interior of the island there are few trails, few large rich valleys, no rich upland plateaus, and consequently few towns, except along the rivers. In the limestone areas, conditions exist similar to those in the cove districts of eastern Tennessee, United States; the country is rugged, sinks are numerous, trails are almost entirely lacking, and the people are little inclined to travel. Indeed, of the whole island one might say that the trails are chiefly the meandering creeks with a cut-off now and then over a ridge, and that the people who do travel from the interior or cross the island do so only because of dire necessity, for the maturity of the topography makes land communication a difficult matter.

Second.—None of the rivers of Samar are navigable except for shallow-draught boats. Launches drawing little water can go up some of the larger rivers, but the entry into the streams is always hindered by the ever-present bars at their mouths.

[5] Forest reconnaissance of Samar, Annual Rep. P. I. Bur. Forestry, app. A (1916) 59–70.

[6] Merrill, Elmer D., New plants from Samar, Philip. Journ. Sci. § C 11 (1916) 175–206.

The ports are little better than anchorages for ocean-going vessels, and are in no way protected from typhoons. The seacoast towns, as would be expected, have attracted more tradesmen and more people than have the isolated interior villages off the rivers. Furthermore, the people in the interior are kept at home by dangerous headwaters of rivers. The narrow San Juanico Strait, along a seismotectonic line, provides a means of water transportation between southwestern Samar and northeastern Leyte; but the windy, rough, and treacherous San Bernardino Strait well isolates Samar from Luzon. Both land and water communications, therefore, are by no means favorable to the economic development of the island.

Third.—The agricultural lands, naturally, are the river valleys and narrow coastal plains. The interior can boast of little tillage, but one cannot blame physiography alone for that. There is entire lack of a large plain approaching that of the Luzon plain, so that it devolves upon the numerous smaller valleys to produce whatever is raised. Much of the land is very fertile and simply awaits development, which to-day is fostered by the schools; but the fact that there are extensive agricultural units has brought about almost a tribal relationship among the inhabitants, who cultivate in one place what little is needed for their own sustenance, and go to the forest for resin, honey, and wax. They do not grow any larger crops than seem necessary to meet their own needs.

Fourth.—The people of Samar, chiefly Visayans, are to some degree held down because of their environment. The natives are not fond of travel, and one can scarcely blame them! Cargadores usually will go from one barrio to another only. Though in the majority of cases poor, the people are usually hospitable, and certainly are more amiable than we have been led to believe by some visitors among them. They know little of their own island and even less about the remainder of the Archipelago, but that is not particularly characteristic of them. The Pulajan religious fanatacism of the early days of the American occupation was certainly not hindered by the nature of the terrane. Better communications will open a potentially rich agricultural province and will aid in the education and unification of the people.

To summarize: The physiography of Samar is, in many ways, unlike that of Luzon and Leyte. Nearly all of this province is maturely dissected; an igneous area is limited in extent, while limestone is abundant. Rivers, shallow and rocky, are extremely

numerous, making water communication a difficult matter. Outcrops are more abundant along the coasts, where they are not so effectively hidden by vegetation. Finally, no great central cordillera is known on Samar, with the result that a large amount of rain is evenly distributed over the entire island.

GEOLOGY

PETROGRAPHY AND GEOLOGY

The following notes on the petrography and geology of Samar are based upon a brief reconnaissance, for during this trip stress was laid upon economic features and only sufficient stratigraphy was undertaken to answer the economic questions involved. Were I asked to-day, "Is the island standing on end or is it flat?" I might say that I am not certain which is the case! Since the trip was merely a reconnaissance and no definite statements regarding broad structure can be made, it perhaps will be best for the reader to travel with the party on its various trips, and let me point out what was actually observed in the field and what laboratory study of the rocks and data brought out later.

Catbalogan and vicinity.—Our first work was done in the vicinity of Catbalogan, and there some interesting relationships were seen. For instance, a study of the formations in this neighborhood, strange to relate, showed the highly inclined strata on the beach to be post-Vigo formations, which are probably earlier than the less-contorted sandstone beds that apparently overlie them. Volcanic activity is evidenced by the presence of tuffs. The only pyroclastic rock collected by the party was taken from an outcrop of tuff on the beach north of Catbalogan, northwest of kilometer post 2 of the North Road. This tuff is a coarse-grained gray rock made up of angular fragments, among which magnetite was noted. A thin section shows abundant fragments of magnetite, some stains of hematite, and broken feldspar crystals in a siliceous matrix.

Still farther north an impure sandstone outcrops at a point 3.4 kilometers on the main road (locality F865). It is bluish gray, fine-grained, slightly calcareous, compact, and feldspathic. The grains are subangular, so that the rock approaches a grit. At the same locality, but overlying the gray series, are strata of impure, buff-colored sandstone that is more weathered. The fossils from these series include specimens of *Globigerina* and other Foraminifera, *Flabellum* (?), *Drillia* (?), immature *Cypraea*, *Turris*, and a form referred to *Cylichna*. They are

all very small and delicate, so that specific determinations are impossible.

Not unlike the above specimens is the sandstone occurring at locality F866, in Catbalogan, at the lighthouse, where the beds are so folded as to form minor anticlines and synclines. The specimen is fairly hard, compact, fine-grained, bluish gray rock, weathering brown. Magnetite and feldspar crystals were recognized among other subrounded grains. The fossils found in it were identified as *Drillia* sp. *a.*, *Dentalium*, *Nucula*, and *Nassa* (?).

Across a small bay from locality F865 at Maolong Point, near the municipal rock quarry, about 3 kilometers north of Catbalogan, are abundant outcrops. A rock from this locality near the water's edge is calcareous, medium- to fine-grained, and contains larger fragments of pure limestone. In it are to be recognized some magnetite, angular fragments of feldspar, and bits of subangular olivine, although most of the grains are more or less rounded. It is a fine-grained limestone conglomerate. Exposed at this locality is a hard, coarse-grained, compact, breccialike rock, a coarse-grained limestone conglomerate. The specimen examined in the laboratory shows a rather unusual association of subrounded felsitic pebbles, fragments of magnetite, quartz (with a small fleck of gold), fractured feldspar, and, much to my surprise, *Lepidocyclina* and *Lithothamnium* in the larger angular fragments of limestone. In the field no recognition was made of the reworked nature of this formation, which was then considered to be Vigo (Miocene) in age. Here is, however, proof of a definite unconformity after Vigo time, and it further indicates that these beds on the beach are probably Pliocene in age. A soft, gray, medium-grained, foraminiferal rock is associated with these conglomerates at this place (F878).

At the top of the rock-quarry hill, only a short distance above these rocks on the beach, is a compact, fairly hard, dirty white limestone, relatively free from impurities, which is distinctly fossiliferous, as is shown by the presence of *Lepidocyclina* and *Lithothamnium* remains. This rock is, beyond doubt, Vigo. While in the field, we recognized that a fault had occurred here, but it was not until the laboratory study of the rocks had been made that the true significance of this fault was appreciated; that is to say, that the bearing the fault had on the unconformity here was defined.

One of the calcareous strata that outcrops at Anas Point, 2 kilometers northwest of Catbalogan, is a hard, compact, dark

gray rock. The angular to subrounded grains of this specimen consist of hornblende, hematite, phenocrysts of feldspar in small igneous pebbles, magnetite, and indeterminable minerals, bound together by a calcareous cement. This is a calcareous grit.

Another specimen from Anas Point (Station 12 + 10.6 H. G. S.) is a fine-grained gray rock that weathers yellow. Under the microscope it has a fragmental appearance; it contains magnetite, limestone, and also *Lepidocyclina* seemingly scattered through the rock, but I have little doubt that it is reworked calcareous sandstone.

Here (F879) likewise outcrops a clastic rock composed chiefly of limestone which, in the field, was thought to be an arkose. This is soft, fine- to medium-grained, light gray calcareous rock, containing fragments of feldspar and spotted by indeterminable, subangular black fragments. *Lithothamnium* and numerous Foraminifera occur in it.

A marl interbedded with a rather granular, compact, grayish white foraminiferal limestone, in which *Lepidocyclina* and the alga *Lithothamnium ramosissimum* Reuss were distinguished, also occurs at Anas Point. This marl is practically the same, even to fossil content, as that to be described from locality F868. The limestone may be fragmental.

Not far from this Anas Point locality on the beach, north 55° west of kilometer post 2 of the North Road, is an outcrop of limestone containing *Globigerina*, *Lepidocyclina formosa* Schlumberger (?), *Lithothamnium*, and *Lepidocyclina* cf. *gibbosa* Yabe, similar to the limestone at locality F868.

When the exposures southeast of Catbalogan are examined, rocks lithologically very similar to those already described from the region north of the provincial capitol probably will be noted. About 1 kilometer southeast of the town at locality F868 in the road cut (Plate 1, fig. 1) there is a good outcrop of a dull, chalky, calcareous, fine-grained, compact, soft, fossiliferous marl, containing abundant *Globigerina* but no *Lepidocyclina*. However, a similar marl occurs between the limestone beds in the formation at the same locality but on the beach. This limestone is in the same stratigraphic sequence as the marl and is blue-gray, mottled, fragmental or breccialike, and rich in *Globigerina*, *Lepidocyclina formosa* Schlumberger, indeterminable gastropods, and algal remains. From locality F869 (close to locality F868) is a yellowish white limestone, which is a little siliceous, but rich in foraminiferal and algal remains.

In general these beds southeast of Catbalogan dip to the northwest and strike northeast, but show considerable variation in both dip and strike within short distances, thus evidencing faulting. Apparently these beds, like those on the beach north of the town, are post-Vigo, and by their nature point to an unconformity between the Pliocene and the Miocene.

Gandara River.—From Catbalogan the party went to Calbayog and then up Gandara River to Matuguinao. Before going up the river, however, we spent a day or so in the vicinity of Calbayog, where we found that the hills southeast of Oquendo, north of Calbayog, present fairly abundant outcrops of lignitic sandstone, one specimen of which is a soft, fine-grained, noncalcareous, friable, buff sandstone. The traverse from Buao to Matuguinao disclosed flat, or nearly flat, outcrops of sandy clay-shale, or marl; while on the trip down the river, we saw evidence, though insufficient, of a westward-sloping monocline, which at places is possibly folded into minor shallow synclines and gentle anticlines, and at places is faulted. The majority of the strikes were northwest. The river in its upper reaches near Matuguinao meanders to a remarkable extent, but cuts through no limestone, although that formation is found at locality F877 near Matuguinao. This is a hard, white Miocene limestone containing *Lepidocyclina* and *Lithothamnium*.

Northeast of this interior barrio, at an elevation of about 400 meters, lying in close association with limestone, is a compact, brown-weathering, blue sandstone, medium-grained, calcareous, and consisting of angular to rounded grains, some of which are feldspar, quartz, and magnetite. It might be called a calcareous tuff.

Cross-island traverse.—The cross-island traverse did not disclose sufficient evidence to warrant any exact statement concerning stratigraphy or structure. It did indicate, however, that there is an igneous core to the island, and we were led strongly to suspect the existence of a basal igneous complex or a basement complex of metamorphics. This traverse is shown in Plate 4 with an explanation of the geological features. From these data an effort was made to construct a profile that would show, at a glance, the structure of the island; but it was found that the information at hand was insufficient to complete the picture, and the attempt was abandoned. I am led to the belief that the central portion of the island is composed, principally, of flat-lying beds of marl and sandstone of possible Pleistocene age and great masses of Miocene and Pliocene limestones

of unknown attitudes that at places project through the later cover or, perhaps, never were covered.

The starting point for this cross-island trip was Wright, or Paranas; the latter is the town's old name. Here there is a prominent cliff of typical marl, one specimen of which gave 27.65 per cent silica in addition to its calcium carbonate content. These Samar marls are usually gray, compact, lignitic, slightly feldspathic, shalelike in appearance, and contain minute, delicate fossils, among which can be recognized, from the beds at Wright, Foraminifera, *Dentalium* sp., *Natica* sp., hinges of a pelecypod, *Nassa* (?) young form, and *Yoldia* sp. (?).

On the road from Wright to Loquilocan outcrops of marl only were noted, and the definite attitudes indicate a north-south strike with a gentle dip to the west. Massive limestone was found near Loquilocan.

The hard, fine-grained red to brown fragments of jasper and chert that were noted in Ulot River point to the presence of chert and jasper in place—probably in the region near Lawaan, north of Loquilocan. No chert was seen in the streams that drain the west coast, and no quartzite at all was observed. It is interesting to note that some curious pottery and worked gold, which may be quite ancient, were found in the vicinity of Lawaan.

For a distance of about 2 kilometers, the course from Loquilocan to Bagakay was by baroto down Ulot River. Soon after we left the barrio, coal was noted outcropping on the bank of the stream. It is overlain by a very coarse, massive, gray calcareous sandstone, and is adjacent to some badly crushed clay-shale. Faulting is evident here.

In the bed of Ulot River, municipality of Wright, about 2 kilometers downstream (east) from Loquilocan, there is a small outcrop of a hard, fine-grained, compact, blue-gray rock, which is unstratified and amorphous and breaks with uneven fracture. In the field this rock was called a quartzite, and even under a hand lens it is certainly very similar to that metamorphic rock. However, a microscopic examination under low power shows a white thin section with black and white dots which are unchanged under crossed Nicols. The black components have a high refractive index. Relatively large phenocrysts of an indeterminable feldspar occur in a fine-grained groundmass of cryptocrystalline quartz, feldspar, and magnetite. This rock is a feldspar porphyry.

After leaving the boat and taking the trail once more, the course lay over limestone, but farther on shattered shale was again encountered, which, with clay, seems to be the principal geologic feature between Loquilocan and Bagakay, although a bowlder of an igneous rock was picked up in a stream between these two places, about 2 kilometers west of Bagakay. This proved to be a compact, fine-grained, dark gray rock, weathering to brown. Microscopically, it is a seriate porphyritic rock, tinged green by chlorite and composed chiefly of partially decomposed plagioclase feldspar, which occurs as lath-shaped simple and compound forms, and larger subhedral crystals, some of which exhibit wavy extinction. Olivine, augite, and chlorite are present. Although the hand specimen resembles andesite closely and the thin section shows some internal andesitic characteristics, this rock, because of its composition, is probably an olivine-basalt.[7] This may be the rock described by Roth as an augite-andesite or dolerite.

After leaving a settlement of two houses, east of Bagakay, the party observed in the bed of a creek a formation that is unmistakably igneous. It is a reddish rock composed of minute ferromagnesian crystals in a dense, vitreous groundmass, with many vugs filled with secondary material. It probably is an amygdaloidal basalt.

The rocks that were most puzzling in the field were specimens from the Wright-Taft trail, 5 to 6 kilometers east of Bagakay and less than half a kilometer from the basalt just described. Weathered specimens of this formation resemble sandstone, arkose, graywacke, or tuff, according to the mood of the observer at the time! At one place (station 30 H. G. S.), there is a definite outcrop which strikes north 45° west and dips 30° northeast. Megascopically, it is a medium-grained, blue-gray rock, and weathers to deep brown. It effervesces but slightly and is characterized by small, white feldspar and quartz crystals in a blue groundmass or matrix. Microscopically, it exhibits rather definite flow structure. It is composed of angular and subangular to rounded crystals, all well fractured and embedded in an apparently fine-textured matrix. Plagioclase feldspar predominates. On some of these crystals it is of interest to note intersecting brushes like an interference figure, showing that the minerals of this rock have undergone strain. It is possible that

[7] Cf. British Petrographic Nomenclature, Mining Mag. 24 (1921) 278–281.

this is an igneous rock that has undergone such pressure as to make it seem clastic. Some magnetite is present. However, despite its apparent clastic nature, I am inclined to designate this rock a dacite (?).

The first Malumbang (Pliocene) limestone to be recorded was found at locality F871. This, as well as the limestone at locality F872, farther east, on Malinao River, is yellow, argillaceous, and fossiliferous, yielding corals and mollusks, but is characterized by the absence of Foraminifera. In contrast to this are all the other limestones we have collected on the island and which are characterized by the inclusion of certain species of *Lepidocyclina* or other Foraminifera.

Between these two limestone localities, about 9 kilometers east of Bagakay, a specimen was picked up and labeled in the field, "Igneous, weathering to clay" because it was seen that the small core of an igneous rock had given rise to the clay which now surrounds it. A microscopic examination shows that the rock is characterized by small plagioclase crystals lying in a dense, glassy groundmass; a few small crystals, probably of hornblende; and some small vugs. On account of its texture and composition, I have classified it as basalt.

East coast.—From Marabgas, the party traveled in native dugout boats down Malinao (Tubig) River to Taft, which lies at the mouth of the river and on the Pacific Ocean. On the way we noted a soft, fine-grained, noncalcareous, argillaceous, tan-colored sandstone, which was badly weathered and contained many plant fragments. The grains are feldspathic to a large extent, are not well rounded, and are loosely consolidated. A clay-shale is also found along this river. On the north bank of the Malinao, opposite Taft, is an outcrop of massive marl, which lithologically is very similar to that at Wright. South of the town are several small, lunar bays, and at their horns' ends Recent coral occurs, while north of Taft to Dolores the trail lies along a narrow, sandy coastal plain.

Embayed and irregular shore lines and the drowning of Malinao River are evidences of subsidence in the vicinity of Taft and Dolores. Coral reefs, also, point to subsidence. Fig. 1 is a profile of the ocean floor east of Taft and shows a gently shelving platform to the 25-fathom line, where there is an upbuilding, then the depths become greater, with fluctuations, out to the Pacific Deep. Fig. 2 is a similar profile from Dolores to Hilaban Island and likewise may indicate subsidence. It is true that

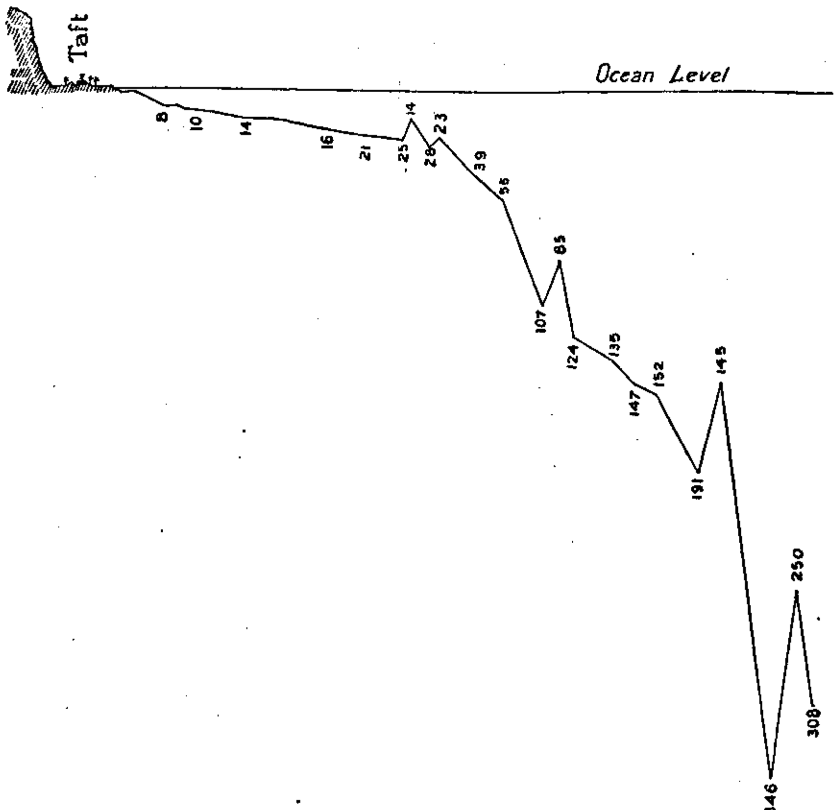


Fig. 1. Taft to the Pacific Ocean, Samar. Profile on east-west line; latitude 11° 54′ 48″, longitude 125° 25′ 30″. Scale: Horizontal about 1 : 150,000, vertical about × 6. Depths in fathoms, from Coast and Geodetic Survey sheet 1422.

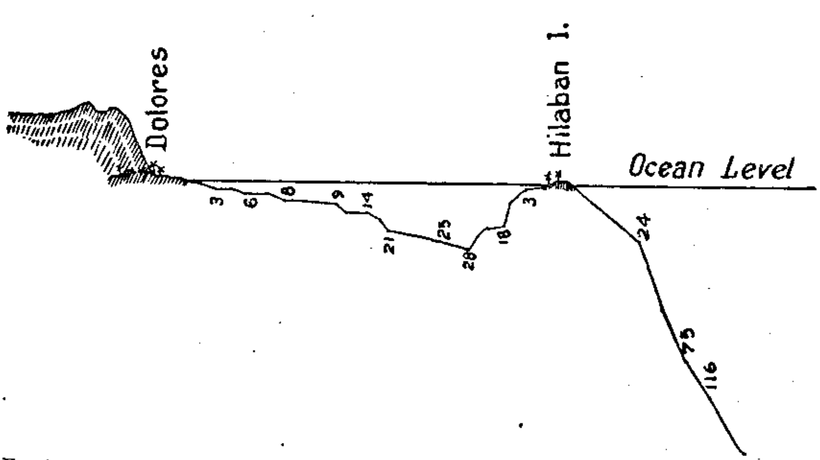


Fig. 2. Dolores to Hilaban Island, Samar. Profile on east-west line; latitude 12° 02′ 20″, longitude 125° 29′. Scale: Horizontal 1 : 150,000, vertical × 8. Depths in fathoms, from Coast and Geodetic Survey sheet 1422.

at this locality the evidence seems to favor the theory expressed by Davis that—[8]

The existence of earlier formed reefs at lower levels, now drowned, is highly probable on many of the Philippine Islands; for the absence of strong cliffs on headlands of their embayed shores indicated the presence of protecting reefs while the coasts were suffering erosion before their recent subsidence; thus, all the more does the absence of an extensive system of offshore barrier reefs, which should have grown up from the preexistent reefs during a slow subsidence, indicate that subsidence was more rapid than reef upgrowth. Moreover, the submarine platforms that border some of the islands are best explained as submerged and more or less aggraded reef plains, on the outer margin of which new barrier reefs have failed to reach the present surface because of rapid and recent subsidence; indeed, some of the platforms have no sign of upgrowing marginal reefs, and these must have been submerged with unusual rapidity at a very recent date.

Elsewhere Davis states:[9]

On the other hand, the northeastern coast of Samar, on the opposite side of the archipelago from Palawan, has a moderately sinuous shore line with delta flats that diminish the initial size of its bays, and fringing reefs that reach forward a mile or so from its points; here the latest submergence cannot be so recent as that of Palawan. But instead of being benched by a submerged platform, the sea bottom off shore from Samar sinks rapidly to a great depth.

As opposed to the theory of subsidence, Doctor Dickerson believes that Davis's conclusions were drawn too largely from the study of Palawan, and that it is possible for uplifts, instead of subsidence, to explain many, but not all, of these features. Dickerson says, in a personal communication:

Professor Davis' largely deductive studies based upon Coast and Geodetic Survey maps of the Philippine Islands are exceedingly suggestive and interesting. However, the Philippines have had a far more complicated history. Many of the islands have been uplifted independently of one another. Thus, studies on the northwest peninsula of Leyte indicate a highly complicated set of movements during the Pleistocene. Coralline limestone of probably Pleistocene age is frequently difficult to distinguish from similar limestone of Malumbang Pliocene age. In places, this Pleistocene limestone attains a possible thickness of 200 to 300 feet. At Rabin Point, northwest cape of Leyte, there are at least four terraces at approximate elevations of 15 feet, 100 feet, 200 feet, and 350 to 400 feet. When one traverses the terraces in the vicinity of Jubay, a small barrio on the west side of this peninsula, 2 kilometers south of Rabin Point, nothing but coralline limestone is observed. The top of the 200-foot terrace 2 kilometers south of Jubay is exceedingly even and is 3 to 4 kilo-

[8] Davis, W. M., Subsidence of reef-encircled islands, Bull. Geol. Soc. America 29 (1918) 517.

[9] Davis, W. M., Fringing reefs of the Philippine Islands, Proc. Nat. Acad. Sci. 4 (1918) 199.

meters in extent in an east-west direction. This thick coating of Pleistocene covers completely Vigo Miocene north of Mount Pampang. A few miles further south of Jubay at Daja, the unconformity between this Pleistocene limestone and steeply dipping beds of Vigo age is observed on the north side of Daja Bay. The terraces described in the vicinity of Rabin Point suggest uplifts or, if you wish to quibble, changes in level of the sea of considerable recency with periods of standstill during which such wide terraces as the 200-foot terrace at Rabin Point were formed. The 100-foot and 200-foot terraces appear to persist over the whole southwest side of Leyte. On the north headland of Tabango Bay, the 200-foot terrace is particularly pronounced. The 100-foot and 200-foot terraces occur likewise in the vicinity of Palompon and are probably present southeast of Maasin on the peninsula south of Baybay.

These terraces record, whatever their origin may be, uplift or change in level of the sea, but it is interesting to note that the latest movement in the region north of Palompon was a local depression. In the vicinity of San Isidro and Arevalo bays excellent proof of such condition is clearly evidenced.

In Bondoc Peninsula, a good Pleistocene fauna was recently collected from a terrace near Pinamuntangan Point at an elevation of 275 to 300 feet. Other evidences indicated still higher terraces in this peninsula.

Recent examinations along the southwest coast of Mindoro indicate extensive cliff sections, which at places for several miles defy the mariner to land. Similar cliff sections occur along Luzon in the vicinity of Manila Bay. In all cases where these cliffs are developed, the rock is compact and resistant to wave and stream erosion and the compactness of rock is the dominant feature of cliff development in the Philippines.

A distinct terrace at 2,000 feet approximate elevation is clear at the south end of Cebu Island, in the vicinity of Alegria. Both geological and biological data indicate that Cebu underwent changes quite distinctive from the neighboring islands of Leyte on the east and Negros on the west.

The party went from Dolores to Maslog by baroto and recorded, for the most part, only outcrops of impure sandstones, or marls, which also were similar to the marl found at Wright. Little more was noted between Maslog and Concepcion, as will be seen from an examination of fig. 3. At this point particular attention should be called to the long regular stretch of Dolores River from Hinolaso to Sumakay, to its long south-flowing tributary, and to a straight stretch of Ulot River corresponding to that of Dolores River. Farther east both rivers meander to a great extent. Assuming the presence of an elevated marine terrace and further assuming that these rivers are antecedent streams, this phenomenon is readily explained, though a low anticlinal structure might be the controlling factor. It has been pointed out that evidences of uplift have been noted at several localities—and the island shown in Plate 1, fig. 1, furnishes marked indication of a terrace—on the west coast of the

island, while definite evidence is not so marked on the Pacific side, although a recurring element [10] in profile of certain portions of the east coast, for example at Palapag Mesa, may point to uplift. Terracing may have been general in extent. I am convinced that the section of Samar just described represents an old Pleistocene marine terrace; should this prove to be the case, Dickerson's idea of extensive terracing would certainly carry considerable weight.

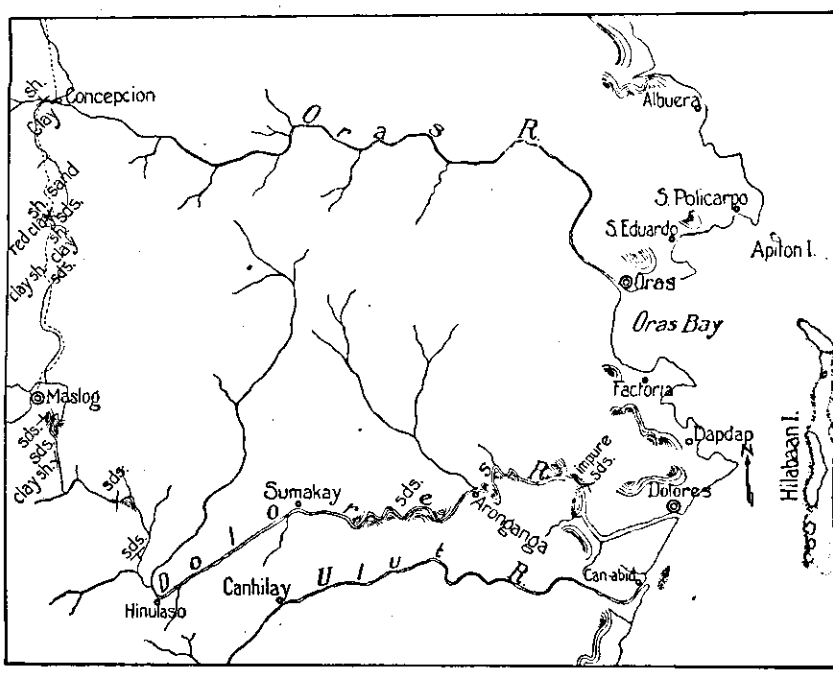


FIG. 8. Drainage control in a portion of the east coast of Samar.

It is on this northeast coast, also, that faulting is observed to some extent. A major fault line doubtless follows the seismotectonic line along the western coast from San Juanico Strait to the northwest corner of the island. The presence of another major fault line or fault zone running roughly parallel to the east coast and probably bounding the Philippine Deep seems to be strongly postulated by phenomena that occurred during recent earthquakes, of which Fr. M. Saderra Masó, S. J., of the Philippine Weather Bureau, writes:

[10] See Hobbs, W. H., Repeating patterns in the relief and in the structure of the land, Bull. Geol. Soc. America 22 (1911) 127.

EARTHQUAKES OF SAMAR, MAY 21 TO 26, 1921

On the afternoon of the said date at 12.45:5 a foreshock of intensity IV–V was felt throughout Samar, and as far as Catanduanes, Sorsogon, and Albay. At 16.43:21 occurred the principal earthquake, which at Batag affected the lighthouse apparatus, so that afterwards it refused to turn: no other damage was reported; yet the intensity of the shock must have reached degree VII at least. The observer at Batag reports that the jerks, both of the principal shock and of the preceding one, were in a nearly east-southeast and west-northwest direction. This earthquake shook Samar, Leyte, Masbate, and Catanduanes Islands and the southeast provinces of Luzon, Sorsogon, Albay, Camarines Sur, and Camarines Norte.

The quake was followed by a series of aftershocks, which did not cease until the 26th. Our seismographs at Manila recorded seven on the 21st, seven on the 22d, eight on the 23d, but two on the 24th, three on the 25th, and two on the 26th. The seismograph at Tigaon, Camarines Sur, recorded some few more; the seismograph of Butuan did the same. Of these twenty-nine aftershocks recorded at Manila, only fourteen were felt at Catbalogan (Batag did not send detailed list, the report says that light aftershocks occurred at intervals); Legaspi and Calbayog felt eight. In the whole series, three only reached degree IV.

The origin of the disturbance lay certainly outside of Samar under the sea. Our records give an average distance of 550 kilometers from Manila; such a distance places the center at about 50 kilometers from the northeast portion of Samar, fully in the Philippine Deep.

October 19, 1897, there occurred in the same region a much-stronger earthquake, which caused considerable damage in the towns of Laoang, Palapag, Oras, Sulat, Gandara, and Catubig: the aftershocks were frequent at Laoang until March, 1898. The epicenter was presumably likewise in the Deep.

The anomaly of Calbayog, with only eight aftershocks, while Catbalogan felt fourteen, is in accordance with what happened in other instances. Calbayog seems reluctant to be shaken; perhaps the geological conditions might give some explanation.

An explanation of this anomaly might be the distribution of rainfall connected with the nature of the formations near Catbalogan; that is to say, the loosely consolidated sediments near Catbalogan when they are water-soaked would make the earthquake shocks more apparent than the less-saturated beds at Calbayog.

Jipapad to Laoang.—The trail from Jipapad to San Vicente extends across several ridges of sandstone and shale, and no other formation was seen during the entire journey from the latter barrio down Catubig River to the town of Catubig. At this town, there is a concrete pavement containing igneous pebbles, and inquiry showed that these were obtained from a branch of the river that flows from the southwest. Clay and alluvium, only, are exposed by the river between Catubig and Laoang, on

the north coast. In 1907, Lieut. Robert Thomas collected three rock specimens from northern Samar and submitted them to the Bureau of Science with a memorandum of localities. To-day only the memorandum can be found. Specimen 1 was a carbonaceous shale which is common in Catubig River Valley. No. 2 was a diorite (quartz?) found in the bed of Palapag River near the town of Palapag. The collector notes: "No stratum found anywhere in river bed." Specimen 3 was a quartz pebble found near the mouth of Palapag River. The diorite, it is thought, points to a dioritic basement complex of Samar.

North coast.—Outcrops, probably of post-Vigo formations, at Laoang strike approximately east–west and, according to Moody, dip north. Farther to the west, near the Catarman Agricultural School, strata of shale, sandstone, and conglomerate, with intergradations, were seen. A specimen of impure sandstone from this locality is medium-grained, buff, heavy-bedded, slightly calcareous, somewhat feldspathic, discolored by iron, and composed of fairly well-rounded grains. The shale is bluish, weathering to buff, while the conglomerate is composed principally of diabase, diorite, felsite, and quartz pebbles, subangular to rounded, averaging 1 to 2 centimeters in diameter, embedded in a gritty, calcareous matrix.

On the north coast of Samar, 2 kilometers east of Carangian, is an outcrop of a badly weathered, coarse-grained, gray rock, which is discolored by iron and speckled with black crystals of pyroxene and many fragments of magnetite. The grains are not well rounded, and though some augite is present, the principal minerals appear to be quartz and feldspar, making the rock an arkosic sandstone or, perhaps more properly, a true arkose. I am led to speculate if this formation explains the statement made by Becker to the effect that—[11]

> In Samar, Jagor found no ancient rocks in place, but sediments which he collected on the north coast appeared to Roth to be derived from gneiss or mica schist.[12]

Moody also collected a specimen of this rock from the same locality, but on the beach; it is rich in feldspar and magnetite, with a little biotite, and appears to be a badly weathered, holocrystalline, igneous rock; if it is, one could say with some certainty that this represents the basement complex of the island,

[11] Becker, G. F., Geology of the Philippine Islands, Annual Rep. U. S. Geol. Surv. 21 [3] (1901) 493–644.

[12] Cf. translation of Roth's paper, Appendix 1, page 263.

and from the nature of these earlier formations one would not expect to find the Vigo and later sandstones anything but the predominantly feldspathic rocks that they are. The interesting feature of this rock, Moody states, is that it is here interbedded with a green shale. This is a slightly calcareous, fine-grained rock, which resembles a jointed clay. No fossils were noted in it.

Balicuatro Point, as observed from a launch, probably is formed of basalt, in part, since the rocks forming it appeared to have the color of that rock and at one place seemed to exhibit characteristic columns of basalt..

Basey to Calbiga and Catbalogan.—The final trip was by launch from Basey to Catbalogan, via Calbiga. A specimen of compact, clean white, foraminiferal limestone, probably Miocene in age, was collected from the seacoast at the sitio of Hilaba, municipality of Basey. This rock is quite free from detrital impurities.

The prominent hill southwest of Basey, southern coast of Samar, is made up in part of conglomerate, a speckled gray, somewhat calcareous, coarse rock in which pebbles of an igneous character, slate, secondary quartz, and fragments of magnetite are distinguishable. The pebbles average less than 1 centimeter in diameter. This conglomerate overlies faulted sandstones and shales of possible Vigo age. It probably is a purely local conglomerate.

In passing through San Juanico Strait, sedimentary beds are seen on each side, though some igneous rocks occur. There is only one rock from Samar in the Bureau of Science collection that was not collected by our party, and this specimen is one that dates from the Spanish régime. It is labeled "traquita anfibolifera" (amphibole trachyte) and is from visita Nabatas, municipality of Villareal, south of Talalora, at the northern end of San Juanico Strait. This rock is dark gray, fine-grained, and compact. Thin sections show that the principal phenocrysts are hornblende and glassy feldspars, though some augite is present, as well as grains of magnetite. The groundmass is made up chiefly of minute crystals of feldspars of another generation than the larger feldspar phenocrysts. This trachyte is similar to a hornblende-andesite from Caibiran on the east coast of Biliran Island.

A noncalcareous clastic rock outcrops at Cologdog Point, near the northern entrance of this channel, and near the town of Talalora. The rock is very fine-grained, compact, buff sand-

stone made up of rounded grains (with a few angular fragments) in a siliceous matrix. Magnetite and feldspar are present.

Interbedded with this sandstone is a medium-grained, compact, light gray calcareous rock, in which specimens of *Lepidocyclina* can be recognized in the limestone fragments between subangular crystals of feldspar, hornblende, olivine, and magnetite. It is an impure sandstone that strikes about north–south, dips at a high angle to the west, and is post-Vigo in age.

In going from Talalora to Calbiga by launch, several limestone islands are passed. Caves on some of these islands were used by the early inhabitants of Samar as burial places. Mr. Joseph Motak, of Catbalogan, presented me with a deformed human skull which he found in a cave on Awacan (Aocon?) Island, near Villareal. The chapel cave, from which Mr. Dean C. Worcester and others made an interesting anthropological collection within the last few years, is in this neighborhood.

Concerning this portion of the coast, Adams says:[13]

> In traveling by steamer from Catbalogan, Samar, to Carigara, Leyte, and returning from Tacloban through the straits and interisland passages to Catbalogan, an opportunity was given to see the islands at close range, but no landing was made. The islands consist of sedimentary rocks with some igneous rocks which appear to form the axis of the trend, and, if they are not a continuation of the igneous rocks of northeastern Leyte, they at least follow structural lines. * * * These [sedimentary beds] are imperfect sandstones and nodular and concretionary argillaceous beds.

Adams states that the outcrops dip at low angles to the eastward. To verify these statements will take more detailed field work, but from what has been stated already, it will be seen that Adams's generalizations may not be fully justified.

Good specimens of marl come from the vicinity of Otoc, near Calbiga, while in the bed of Palongi Creek, near the town (station 45 H. G. S.) is a hard, gray arkosic sandstone, speckled with black dots. It is compact, medium-grained, and made up of angular to subrounded grains of magnetite, hornblende, feldspar, and secondary calcite.

Petrography.—The detailed study of the rocks of Samar brought out several points, which will be reviewed here. The changes in thickness of sedimentary beds varies within short distances, and torrential rains of the earlier periods doubtless

[13] Adams, G. I., Geological reconnaissance of the Island of Leyte—with notes and observations on the adjacent smaller islands and southwestern Samar, Philip. Journ. Sci. § A 4 (1909) 351, 352.

caused the confusing heterogeneity of sedimentation observed to-day in the Tropics. There is not a great variety of minerals making up the various sedimentary formations. Almost without exception, these rocks are calcareous and the sandstones are not made up of pure quartz grains; instead, feldspar predominates. Because of this, the grains vary in size and shape and lack the well-rounded appearance of true sandstone grains. This is what one would expect, considering that not one of the igneous rocks noted is definitely acidic in character, and that the basement complex is probably dioritic in character. The reworked Vigo rocks indicate a period of erosion after the Miocene.

Structure.—An insufficient amount of definite information was obtained by the reconnaissance party to work out, in any detail, the broad structural relationships of the land, and before any conclusions can be reached several very important points must be determined. Among the things that remain to be determined or about which some doubt now exists are: The extent of the Miocene beds, the presence of unconformities, the distribution of igneous rocks, the time of earth movements, whether marine terraces are local or general in extent, the lines of major faulting and folding, and whether or not the island has been differentially tilted. The data now in hand are sufficient for economic purposes and show, among other things, that the island has an igneous core; that there are some monoclinal strata, minor folds, much faulting, and unconformity after the Vigo Miocene. The information also indicates other suspected unconformities, a definite topographic unconformity between the Pleistocene and Recent formations, and complex earth movements.

HISTORICAL GEOLOGY

The ups and downs of Samar have been many. They began in pre-Miocene times and continue at the present day. To write a complete and accurate geologic history of the island is well-nigh impossible; but it is not impossible to recount a few of the principal happenings and to show how the predominant and characteristic fossil life, as preserved, belongs to the Foraminifera. The geologic relationships herein set forth are tentative only.

The existence of pre-Tertiary formations is inferred, but not certain. Evidence points to what may be metamorphosed sediments, as well as basic igneous material, as the basement complex of Samar; and a great deal of evidence, both botanical and zoological, points to a former land connection of the Philippines with other islands. For instance, plant affinities of the outer arc

of the Philippines (eastern Mindanao, Samar, and eastern Luzon) are much closer with Celebes, the Moluccas, and New Guinea than with any part of the Sunda group (Sumatra, Java, Borneo).[14] It may be, then, that in pre-Tertiary times, Samar was connected with other land masses, although it likewise is probable that a separate island then existed and a connection came later. But, whenever the separation occurred, it seems definite that upon the basement complex were laid various sediments, in a manner similar to the sedimentation of to-day.

The Miocene formations consist of the earliest unaltered sedimentary rocks. As a rule, the sandstone beds contain few fossils, but the limestones are rich in *Lepidocyclina.* Under the microscope, one recognizes this small marine animal by its attenuated ends and bulging center; by the "medial plane composed of chamberlets arranged in regular annuli around a distinct central chamber or chambers. The genus has lozenge-shaped or spatulate-formed chamberlets." (Chapman.) Cushman [15] thinks that in America this genus ranges no higher than the Oligocene; but in the Philippines the presence of *Lepidocyclina* has been found to indicate Miocene strata, with probably no range into the younger formations.[16] That the genus has a short vertical range is not doubted, and it is thought that the small forms found in Samar rocks indicate middle and upper Miocene deposits. While the Miocene limestones are rich in this index fossil, coral remains are astonishingly meager.

While limestone was being formed, the old basement complex of the island was suffering erosion. Feldspathic sands and clay were being carried into the seas, mixed with calcareous and lignitic material, and consolidated, and finally the beds were uplifted and folded, perhaps with the aid of volcanic intrusions.

Following the Miocene was a long interval of quiet water deposition and an equally marked period of erosion of the Miocene beds. The limestone of the Ep-Pliocene contains abundant mollusks and corals. Although the genus *Lepidocyclina* had by that time become extinct, other Foraminifera still abounded in

[14] According to E. D. Merrill, in a personal communication.

[15] Cushman, J. A., American species of Orthophragmina and Lepidocyclina, Prof. Paper U. S. Geol. Surv. 125-D (1920).

[16] See Douvillé, Henri, Les Foraminiféres dans le Tertiaire des Philippines, Philip. Journ. Sci. § A 6 (1911) 53; Smith, Warren D., Contributions to the stratigraphy and fossil invertebrate fauna, Philip. Journ. Sci. § A 8 (1913) 235; Yabe, H., Notes on a Lepidocyclina-limestone from Cebu, Science Reports Tohoku Imperial University, II (Geology) 5 [2] (1919).

the seas. At places, Miocene limestone must have stood out as prominent headlands. The wave action that wore away the rock partially rounded the fragments that contained this characteristic Miocene fossil, and then cemented a new rock, including in the product rounded pebbles of igneous formations; or it may be that at places the burden of the streams failed of influence, and there was formed, instead, a new limestone out of the fragments. Stream action may have accomplished the same results.

The Pliocene was followed by an interval of erosion. In the Pleistocene seas corals again lived, and in these waters marls, shales, and sandstones were consolidated. During this period the marine terracing took place and subsidence of portions of the island occurred.

The Pleistocene is separated from the Recent by a marked topographic unconformity, and in this, the latest time, the dominant features again appear to be uplift, subsidence, and the growth of reef corals; and to-day Samar is subjected to great erosion accompanied by the conveyance of vast quantities of material by the numerous streams into bays such as the one at Wright, which is being filled gradually. Thus, youthful are transformed into mature shore lines. If we project the conditions of to-day into the past, we find warrant for the belief that in late Tertiary and Recent times Samar has been unstable and that life in the shallow waters bordering the coast has always been abundant.

ECONOMIC GEOLOGY

It has been pointed out that the ragged island of Samar is of relatively recent origin and that sedimentary rocks are by far the most abundant ones. The economic mineral products of Samar remain to be discussed under metallic and nonmetallic minerals. A summary of this entire subject is simple and may be expressed by the statement: "No commercial deposits were encountered."

Metallic minerals.—Our party found no important economic metallic minerals in Samar, and this is what would be expected, judging from the character of the formations observed. Gold has been reported from the mouth of Pambujan River and from other streams, but the only gold seen by me was a microscopic fleck in a reworked limestone conglomerate. Copper is reported on Capul Island. It is said that lead occurs at places. I saw no formations that hold any promise of metallic productivity. It must be borne in mind, however, that the reconnaissance did

not include a trip to the northwest corner of the island. When one considers, moreover, the labor and market conditions, the cost of supplies and transportation, and taxation, it is evident that Samar is not a favorable field for activity in the mining of metallic minerals.

Nonmetallic minerals.—The general conclusions with regard to metallic minerals hold true with reference to the nonmetallic ones. However, realizing that in some cases negative information is as valuable as positive, I desire to call attention to the economic possibilities of coal, petroleum, stone, clay, rock, and gravel, and artesian water in Samar.

Coal.—Samar coal is still too "green" to be of much value, and the seams are not of sufficient size to warrant mining at the present time. Two samples, whose analyses are given in Dalburg's paper on the coal resources of the Philippines [17] show the following:

TABLE 1.—*Analyses of Samar coal.*

Source of sample.	Moisture.	Volatile.	Fixed carbon.	Ash.	Sulphur.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Wright (Paranas) [a]	16.78	37.75	36.53	9.54	2.82
Llorente [a]	12.43	31.43	30.46	25.68	10.57
Liguan (East Batan) [b]	6.08	40.36	51.24	2.32	0.40

[a] It is not known if these are outcrop samples. [b] For comparison.

The comment that this lignite from Samar is a poor grade of coal is hardly necessary. No good prospects were noted, although on its cross-island trip, the party found specimens of woody lignite at various places between Loquilocan and Bagakay, and in the clay beds of most of the rivers one can pick up much lignitic material. Outcrops also were seen on Calbiga River, typically near Otoc; on Gandara River; and near Oquendo, on the west coast. The coal probably was deposited in local Pliocene [18] or later basins, and frequently the deposition was during torrential rains, so it would not be at all surprising if the beds thicken and thin to some degree. Faulting of the seams was observed. Therefore, the coal of Samar, in addition to being of poor grade, is geologically unfavorable for development.

[17] Dalburg, F. A., Mineral Resources of the Philippine Islands for the year 1911. Manila (1912) 62.

[18] *Vicarya callosa* Jenk., a good coal-horizon index fossil, was not noted in any of the formations.

Coal has been reported from various localities. Becker says:[19]

> In Sámar, according to Centeno, the coal deposits of Sorsogon continue. He gives a locality, Loquilocon, and Mr. Abella mentions Gándara and Paranas. The last two towns are on the west coast, at a considerable interval. A line drawn through them would pass near Gatbó, and its direction would be very like the strike of the bed at the last-mentioned place, differing some 60° from the prevalent strike in Cebú.[20]

Residents of Samar report coal from Borongan; Catarman River, near Lope de Vega; and other localities, making it apparent that Becker based his conclusions upon too little evidence.

Petroleum.—Samar, in the part visited by us, is considered an unfavorable field for the accumulation of a commercial supply of petroleum. This is based upon the following: First, no seep was seen and none was reported to us; at places where one might expect to find seepages, nothing is seen resembling petroleum or even suggesting it. Second, structure suitable for the accumulation of a commercial supply of petroleum was not encountered. Furthermore, the conditions of quiet, shallow, and stagnant water deposition during much of the history of the island, and the presence of resin and lignite in the different beds, make it improbable that petroleum exists in Samar.

Stone.—The cost of stone depends, among other factors, upon its availability and its workability. In Samar, as has been noted, the most probable markets for any stone are the towns along the coast, which are situated at some distance from the supply; that is, the neighboring islands or the interior of the island. There is no sandstone that would serve as a good building stone, no roofing material, and no granite. The limestone, with a probable life of twenty to forty years in a drier climate, is frequently too soft to be of much use and, furthermore, it probably would be difficult to quarry. Coralline limestone and fragments of coral have been utilized as building stone in the construction of some of the churches. Because these materials weather rapidly, a false impression of great antiquity of the building is produced. Samar in its present stage of development would offer a poor field for the quarryman, since the stone that is found there is not readily available and is not of excellent quality.

[19] Becker, G. F., Geology of the Philippine Islands, Annual Rep. U. S. Geol. Surv. 21[3] (1899–1900) 571.

[20] Strike at Gatbo, north 20° west.

Rock, sand, and gravel.—I saw no good quartz sand in Samar. It is true that sand occurs, but the grains are angular and feldspathic. The fact that the concrete street at Catubig contains igneous pebbles and bowlders has been stated. That there are no deposits of good sand and gravel is not surprising when one considers the nature of the country rock and the history of the island. Igneous rock for road metal is difficult to obtain.

The rock, sand, and gravel used on the roads of Samar in 1920, according to an official report, amounted to 8,474.57 cubic meters, costing 24,963.22 pesos. The coralline limestone cost 5 pesos per cubic meter, and gravel as high as 7 pesos per cubic meter, while the lowest figure was 1 peso per unit for coral.

For purposes of comparison Table 2 is given.

TABLE 2.—*Rock, sand, and gravel used in the Philippines during 1920.*

Locality.	Amount.	Cost.	Average cost per cubic meter.
	cu. m.	*Pesos.*	*Pesos.*
City of Manila	65,525.05	94,731.73	1.45
Cebu	10,342.72	17,948.13	1.93
Rizal	9,947.00	28,348.30	2.85
Samar	8,474.57	24,963.22	2.95
Pampanga	6,116.52	27,740.00	4.53

Clay.—A sample of clay from near Matuguinao, at a place locally called "Fairy Land," shows the following:

TABLE 3.—*Analysis of clay sample from Matuguinao.*[a]

	Per cent.
Loss on ignition	47.50
Silica, SiO_2	26.37
Ferric oxide, Fe_2O_3	10.64
Alumina, Al_2O_3	13.20
Lime, CaO	0.21
Magnesia, MgO	1.57
Potassium oxide, K_2O	0.21
Sodium oxide, Na_2O	0.49

[a] Analysis by R. H. Aguilar, Bureau of Science.

This probably is a residual clay, low in silica and relatively high in iron. It is plastic, but would not make a satisfactory china clay; at best it would yield only an inferior building brick. I saw no deposit of good clay.

Artesian water.—In 1909, George I. Adams, geologist in the Bureau of Science, submitted a report on conditions governing

the drilling of deep wells at Catbalogan and Calbayog. This report was not intended for publication, but I am taking the liberty of quoting a few of Adams's conclusions:

The fact of the existence of the springs to the south of the town (Catbalogan) suggests that the formation above sea level retains good water. It may be that the formation below sea level also contains good water, but until a test is made this cannot be determined. If it is decided to drill a well at Catbalogan, it would be advisable to place it inland at the base of the hills southeast of the town so that a reservoir could be placed on the hillside and a gravity system be installed in case a good supply of water were encountered. In drilling at Catbalogan a heavy rig will be required.

If a well is drilled at Calbayog, it is recommended that it be placed at the base of the hills northeast of the town, direction north 60° east from the church. It would accordingly be located about five blocks from the edge of the town. The adjacent hills would furnish a reservoir site and allow of the installation of a gravity system by pumping from the well. It may be that the formation of the west coast of Samar contains salt water below sea level and that the well at the locality above mentioned would encounter salt water, but if so, the experiment would condemn a large extent of the coast where wells must obtain water below sea level.

From the information concerning the mineral resources of Samar now in our possession, the conclusion may be drawn that it is an unpromising field for any activity in this line. Many minerals, including gold, copper, lead, graphite, and phosphate, are much talked about, but no specimens were shown to us. Our informants assured us that "if they were sure they would get something out of it" they could readily prove their statements. Of course, further prospecting may bring to light minerals that are more accessible and perhaps in some quantity, but Samar at present does not appear to be a rich mineralogic province.

APPENDIX 1

[Translated from Ueber die geologische Beschaffenheit der Philippinen, by J. Roth, Appendix II to Jagor's Reisen in den Philippinen. Berlin (1873) 351-354.]

In the Catarman River (north coast of the island) between Catarman and Cobo-Cobo, there are rather compact, ferruginous clay banks of a light brown color, without lime but containing remains of carbonized plants and also numerous bore-holes, which, according to Dr. von Martens, are caused by *Modiola striatula* Hanley which is often present in the holes. After elutriation, the clays leave a varying residue composed of quartz, partly in ferruginous rounded grains and partly as angular splinters; some magnetite; white, gray, and green mica; and feldspar. Some brown, ferruginous layers of almost pure sand of rather large grains exhibit the same composition. Similar, but green, sandy layers occur farther upstream in Catarman River. After treating with hydrochloric acid, one notes in the sediment besides magnetite much white quartz, here and there with

some dark mica; also feldspar and white and dark scales of mica. On the Salta Sangley, farther south, occur blue-gray clay banks made up of sandy, greenish layers which contain the same minerals. In the river starting farther south and near Salta Sangley and flowing from the rectory at Tragbukan to Calbayog, are found soft, rounded bowlders of a badly weathered rock, coming from the headwaters of the river. In it are recognized white, and some dark, mica and it contains, after washing the clay away, a sediment of, in part, ferruginous quartz, feldspar, and some magnetite. Accordingly, these bowlders probably come from a gneiss or feldspar-rich mica-schist.

Farther downstream below the Tragbukan chapel there appear again green and brown, ferruginous sandstones, slightly consolidated, and made up of coarse grains, and having the composition already mentioned. This relationship shows that these banks, as those above mentioned, came from a weathered gneiss or feldspar-rich mica-schist. In all these clay and sandstone strata there is no larger fragment of rock which would throw more light on the subject.

Still farther downstream are brown, fine-earthy, compact, calcareous clay banks, with indistinct petrifactions. The residue after treating with hydrochloric acid, shows only some scales of mica and quartz grains.

Farther southeast on the coast near Catbalogan and on the neighboring Mojava Island appear volcanic tuffs. These are rather compact, slightly clayey, coarse-grained, and greenish gray in color. They contain, besides numerous fragments of augite, some rounded crystals of this mineral, much magnetite, white feldspar, and some pieces of stone which are the same as some of the foregoing larger fragments of rock. The gray, thick, compact rock contains in a feldspathic groundmass much green augite and separate crystals of magnetite. After treating with boiling hydrochloric acid, the groundmass becomes white and is strongly attacked. This behavior and the very small number of small triclinic feldspar crystals show that the rock has come from a porphyritic dolerite or pyroxene-andesite. A rounded bowlder taken from the same block of conglomerate carries green augite in the thick brown groundmass. The numerous round cavities are filled with stilbite and opal; the tuffs have a hardness of 2.5 and dip 80° north.

At Catbalogan we find gray and brown banks, which are somewhat argillaceous, partly consisting of very fine sand. The powder yields magnetic iron to a magnet. They (the banks) sparingly contain triclinic feldspar, augite, and fragments resembling pumice, sometimes also fragments of a very dark, thick rock in which can be recognized single triclinic feldspar crystals. In connection with the origin of Mojava, these formations may be considered as derived from doleritic rocks.

These banks were in part overlain by a layer of soft, yellowish gray, fine-grained limestone. The latter, on treatment with hydrochloric acid, leaves a residue consisting of numerous clayish particles, some feldspar, augite, and magnetic iron, and small, gray particles of stone; in part, calcareous sediments, which have a hardness of 5 to 5.5 and dip 35° north, and are thick, compact, and light gray in color. The lower layers are mixed with volcanic tuff and calcareous sediment.

Close to the seacoast near Paranas [Wright] to the east of the bay, one notes a hard shell breccia; that is, shell fragments cemented with lime, in large, crushed bowlders lying on softer banks of the same material. Out

of the latter one can recognize, according to Dr. von Martens, among the numerous shell fragments, *Plicatula depressa* Lamarck, which is still living in the Indian Ocean. The yellowish gray clay banks under these horizontal layers dip inland. According to Dr. von Martens, from among the fairly well-preserved shells and pteropods, one can identify, in part, the following species [genera]: *Yoldia, Pleurotoma, Cuvieria, Creseis, Dentalium,* which still live in the Indian Ocean. The species *Pleurotoma* is not identified with any one living species. With the living species can be recognized the following: *Venus* (*Hemitapes*) *hiatina* Lam., *Venus squamosa* L., *Arca* (*Scapharca*) *cecillei* Phil., *Arca inaequivalvis* Brug. var.,[a] *Arca chelcanthum* Rv.?, *Corbula crassa* Rv., and *Natica unifasciata* Lam. var. *lurida* Phil.

In the forest between Paranas and Loquilocan which stretches to the northeast and toward the land are cliffs of solid, grayish white limestone, resembling conglomerate, interwoven with veins of calcareous spar (calcite) and in which may be recognized indistinct organic remains, perhaps of corals. In the Loquilocun River, which directs its course toward the northeast to the east coast of the island, there are, below the Loquilocun chapel, brownish yellow, badly weathered calcareous sediments in great unstratified masses. The coal which forms an alluvial deposit near the sixth rapids below Loquilocun is rich in pyrites and interwoven with gypsum, and is similar to the wood of lignite. Its woody structure can be seen with the naked eye and it gives a brown powder.

From a large alluvial deposit of gravel and rubble opposite the rapids below Loquilocun, where the boat must be unloaded for the first time and the cargo carried overland, can be obtained the following: (1) A much-altered, granular, red-gray rock veined with epidote; in it can be seen, besides quartz and triclinic feldspar, a fair number of points of magnetite; it does not impress one as an eruptive rock and could belong to the feldspar series of hornblende-schists; (2) a blue-gray, porphyritic rock whose vitreous groundmass (lacking the property of double refraction) is filled with small sphalerites and contains sparingly small grains of quartz and magnetite, besides larger dull white feldspars. Only on one of the crystals could the triclinic bands be recognized with certainty. The rock is probably a recent eruptive but a further classification is doubtful; at any rate, the presence of quartz in the vitreous groundmass is of interest. The grains of quartz cannot be considered as incrustations; (3) farther on is an agate of milky white color, one of the amygdaloids, as the surface proves; (4) red-brown jasper interwoven with fine quartz veins.

Bowlders from Basey River (southern coast of the island) accumulated at the Sogoton cave, are composed of an old eruptive rock. It contains in a fine-grained dark green groundmass dull white feldspar, a little magnetite, and some indeterminate greenish crystals, which may be considered to be augite. Conforming to this composition and the behavior of the rock and the feldspars with boiling hydrochloric acid, the rock belongs to an oligoclase-augite-porphyry. The red-brown, ferruginous soft rock which occurs near the preceding one and which effervesces in acids and

[a] The teeth are somewhat more numerous and smaller than in *A. aequivalvis* Brug. Jagor, Philippinen.

with a feldspar that acids decompose completely, may be a tuff coming from a similar porphyry. In the bed of Sogoton River north of Basey are bowlders of talc- and chlorite-rocks.

The Sogoton cave is formed of calcareous cliffs in which one recognizes traces of bivalves and spines of echinoderms. In front of the grotto are situated, at a height of 20 feet [about 6 meters] above the river on the right bank, banks with marine shells. There are species still living; according to Dr. von Martens, *Venus* (*Hemitapes*) *hiatina* Lam., *Arca* (*Scapharca*) *cecillei* Phil., *Arca uropygmelana* Bory, and *Placuna placenta* L. The shells scarcely adhere to the tongue; therefore, the deposit must be very recent. On one of the small islands near Nipa-Nipa (Basey) are found, on the raised shell banks situated at a height of 60 feet [about 20 meters] above sea level, the following living species (according to Dr. von Martens); *Chama sulfurea* Rv., *Pinna* cf. *nigrina* Lam., *Ostrea denticulata* Born, *O. cornucopiae* Chemn., and *O. rosacea* Desch. On the coast west of Basey is an incoherent aggregate of shell fragments with isolated, rounded, small bowlders.

APPENDIX 2

FOSSIL LOCALITIES, SAMAR ISLAND

Locality F865.—Catbalogan, 3.4 kilometers north of the town, on main road, south 40° west across bay from quarry and about 0.5 kilometer north of barrio of Maolong. Prominent exposure of gray sandstone overlaid by buff sandstone, with small normal fault in approximate center. Strike north 10° west, dip 6° northeast, with doubtful plunge of 4° northwest. Alternate layers of sandy material in sandy shale. Lower series contains small, poorly preserved fossils and some carbonaceous material, including pockets of amber. Small, thin laminæ and strata average approximately 15 centimeters. Deeply weathered. Upper series, compact, fine-grained, buff, calcareous sandstone, which is fossiliferous (contains *Globigerina*) and carbonaceous. This locality is readily identifiable by fault. The height of exposure is about 6 meters, though in the immediate neighborhood this figure will vary from 0.5 to perhaps 10 meters. The road cuts nearly along the strike of beds. Collector, H. G. Schenck, November 1, 1920.

Locality F866.—Catbalogan, on right bank of Antiao (Catbalogan) River, between suspension bridge at north end of Calle del Rosario and mouth of river and continuing around Light House Point. Exposures of sandstone varying in texture from sandy shale to buff, compact, hard sandstone, each stratum averaging about 3 decimeters in thickness. Fossils small and poorly preserved, falling to pieces upon exposure. Strike east and west, dip 15° northeast. Small fault in exposure, dying out in upper beds. Beds exposed by tide; strike north 87° west, dip 21° northeast. Outcrops sandstone and shale upstream to point 200 meters from mouth have varying strike. Small, well-defined folds, making series of plunging anticlines and synclines, occur at locality. Collector, H. G. Schenck, November 2, 1920.

Locality F867.—Lepidocyclinal limestone on south-southwest side of quarry hill on beach approximately north 55° west from kilometer 2 post, Catbalogan North Road. Fine- to medium-grained sandstone, and sandy

shale seem to grade into conglomeratic limestone, striking north 30° west. Stratigraphically above this limestone is a fine-grained buff sandstone, containing some carbonaceous matter and amber. Higher in series are white shale (marl?) and heavy-bedded, medium-grained, buff sandstone. All beds dipping at high angle. Above sandstone is a calcareous sandstone. Collector, H. G. Schenck, November 4, 1920.

Locality F868.—Catbalogan, about 1 kilometer southeast of Catbalogan pier, outcrop white, chalky marl with small intercalated layers of limestone. Outcrop characterized by color (white). This is in road cut. Fossiliferous material from intercalated fragmental limestone on beach, overlain and underlain by hard, white marl. As one walks on beach across outcrop, the strike changes from north 65° east, dip 122° northwest, to north 85° east, with variations in dip. South 45° east from first rocky point on beach southeast of Catbalogan, about 80 meters from public washing place, is outcrop of dark fragmental limestone between layers of hard marl. Fault cuts series. Collector, H. G. Schenck, November 5, 1920.

Locality F869.—Catbalogan, orbitoidal (lepidocyclinal) limestone from outcrop on beach at small bridge southeast of rocky point about 1.1 kilometers southeast of Catbalogan. Alternate layers of limestone and marl. This limestone is light-colored in contradistinction to the dark limestone at F868. Doubtful attitude north 50° east, dip 30° northwest. Collector, H. G. Schenck, November 5, 1920.

Locality F870.—A. Wright; old name of town is Paranas. Prominent cliff at southern end of town, immediately south of old church, made up of slightly fossiliferous, bluish marl, containing *Globigerina,* with intercalated, hard layers of same material but lignitic. Strike north 40° east, dip 0° to 10° west. Normal fault: no attitude. Hard layers of more indurated phase of marl stand out definitely.

B. At northern side of cliff, stratigraphically unconformably above A and 1 to 2 meters below surface of ground occur vertebrate remains in clay soil. Bones (some human) associated with Recent shells which are stratified and in one place cross-bedded. Bones scattered for a distance of about 5 meters horizontally. Probably a raised beach or old stream deposit, Recent in age. It is not probable that this is an old cemetery, since there is none here now; natives know of no old graveyard, and an old well is 10 meters from locality. Collector, H. G. Schenck, November 15, 1920.

Locality F871.—Coralline Malumbang (Pliocene) limestone at elevation 390 (?) feet (about 130 meters) on Wright-Taft trail, about 7 kilometers in easterly direction from Bagakay and upstream from Marabgas on Malinao River. Small stream at base of 10-meter cliff flowing here north 60° east. Collector, H. G. Schenck, November 19, 1920.

Locality F872.—Fossiliferous Malumbang (Pliocene) limestone on left bank of Malinao River about 0.5 kilometer downstream from place where Wright-Taft trail first touches this river. Steep limestone hills on each side of stream, probably 200 meters high. Locality from which specimens taken is 15 meters above water and about 5 kilometers upstream from landing called Marabgas, municipality of Taft. Collectors, Moody and Schenck, November 19, 1920.

Locality F873.—About 0.5 kilometer northeast from landing at sitio of Otoc, on Calbiga River, 3 kilometers upstream from Calbiga. Outcrop

lignitic and fossiliferous, bluish marl, containing *Globigerina* and resembling material at Wright. Elevation about 80 meters. Dips slightly to southwest, but attitude not definite. Strike may be north 20° east. Creek flows over outcrop to river; downstream marl overlaid by fine-grained buff sandstone (thin layer) occurs. Coal seam at this locality 1 to 5 centimeters thick. Same material exposed along river from Calbiga to Otoc. Collector, H. G. Schenck, December 6, 1920.

Locality F874.—Malinao (Tubig) River near Taft. Fossiliferous and lignitic buff sandstone with clay at same exposure. Collector, G. B. Moody, November, 1920.

Locality F875.—Basey, sitio of Hilabá, Samar, south and east of Tacloban, Leyte. Outcrop of foraminiferal limestone; vertical exposure about 20 meters; shore runs east and west at locality. Prominent cliff undercut by wave action. Collector, H. G. Schenck, December 1, 1920.

Locality F876.—Municipality of Villareal (?), Gologdog Point, about 1 kilometer southwest of Talalora at northern entrance to San Juanico Strait, across from Daram Island. Outcrop of alternating beds of indurated sandstone and fine-grained, calcareous conglomerate containing Foraminifera, striking north 5° west, dip 72° to 90° southwest. Collector, H. G. Schenck, December 2, 1920.

Locality F877.—Municipal district of Matuguinao, about 2 kilometers southeast of barrio at spring. Foraminiferal limestone apparently disturbed by minor faulting. Stream at locality flows south 10° west. Collector, H. G. Schenck, November 10, 1920.

Locality F878.—Catbalogan, Maolong Point, north of town at rock quarry, about 0.5 kilometer northwest of main road and about 2.8 kilometers north of Catbalogan. Limestone breccia (coarse-grained limestone conglomerate) and impure soft limestone (F. N.) both containing Foraminifera. Beds are evidently reworked material, strike northwest and dip to northeast. At top of hill is pure limestone, also containing Foraminifera. Collector, H. G. Schenck, November 1, 1920.

Locality F879.—Anas Point, about 2 kilometers north of Catbalogan and north 60° west from flagpole on pier. Calcareous beds striking northwest disturbed by faulting. Foraminiferal limestone interbedded with a softer, shalelike (marl?) formation. Collector, H. G. Schenck, November 4, 1920.

BIBLIOGRAPHY OF GEOLOGY OF SAMAR

1873. JAGOR, FEDOR. Reisen in den Philippinen. Berlin, Weidmannsche Buchhandlung **16** (1873) 381 pp. English and Spanish translations incomplete.

1876. CENTENO Y GARCIA, JOSÉ. Memoria geológico-minera de las Islas Filipinas. Bol. de la Com. del Mapa geológico de España **3** (1876) 216.

1901. BECKER, GEORGE F. Report on the Geology of the Philippine Islands. Annual Report U. S. Geol. Survey **21**[3] (1901) 493–644.

1904. SADERRA MASÓ, MIGUEL. Volcanoes and seismic centers of the Philippines. Census of the Philippine Islands **3** (1904) 40–41.

1909. ADAMS, GEORGE I. Geologic reconnaissance of the Island of Leyte, etc. Philip. Journ. Sci. § A **4** (1909) 339–356.

Report of the Philippine Commission, Appendix; Mineral Resources, etc. Washington, Government Printing Office.

1913. SADERRA MASÓ, MIGUEL, and SMITH, WARREN D. The relation of seismic disturbances in the Philippines to the geologic structure. Philip. Journ. Sci. § A 8 (1913) 199–232.

1916. PRATT, WALLACE E. Philippine Lakes. Philip. Journ. Sci. § A 11 (1916) 236.

1918. DAVIS, W. M. Fringing reefs of the Philippines. Proc. Nat. Acad. Sci. 4 (1918) 199.

1920. Census of the Philippine Islands. Manila, Bureau of Printing 1 (1920).

ILLUSTRATIONS

Fig. 1. Coast near Catbalogan, Samar; locality F868.

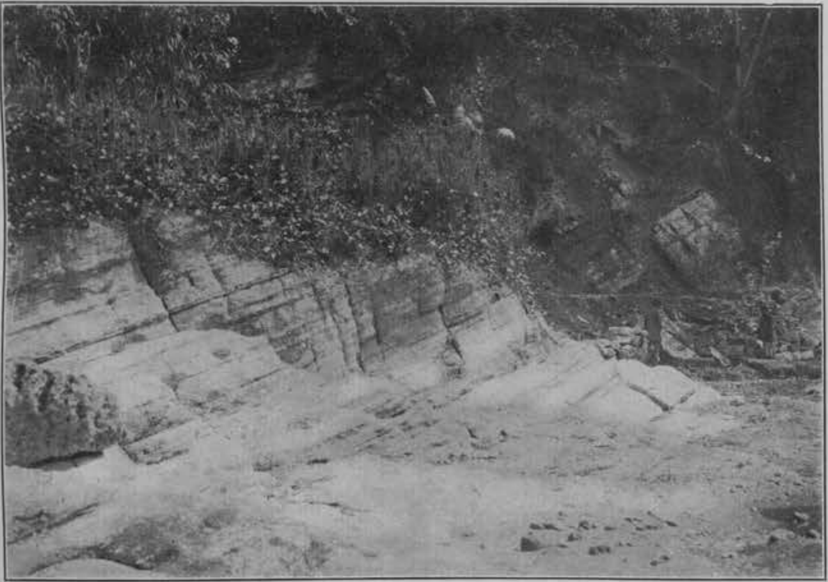
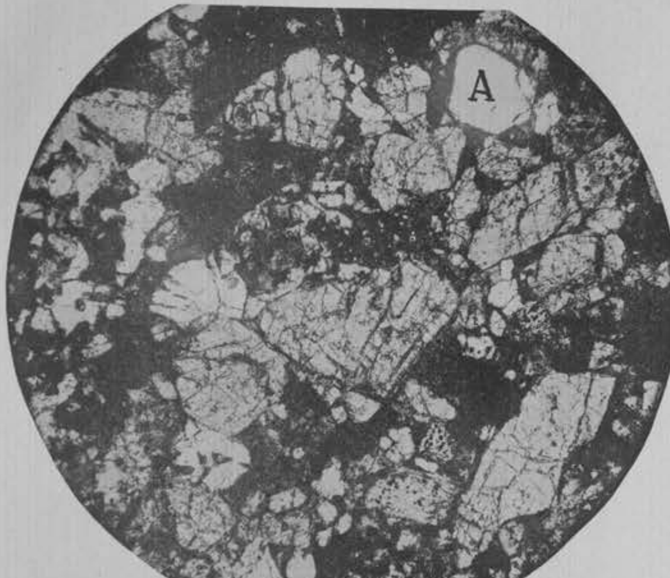


Fig. 2. Dipping marl beds south of Catbalogan, Samar; locality F868.

PLATE 1



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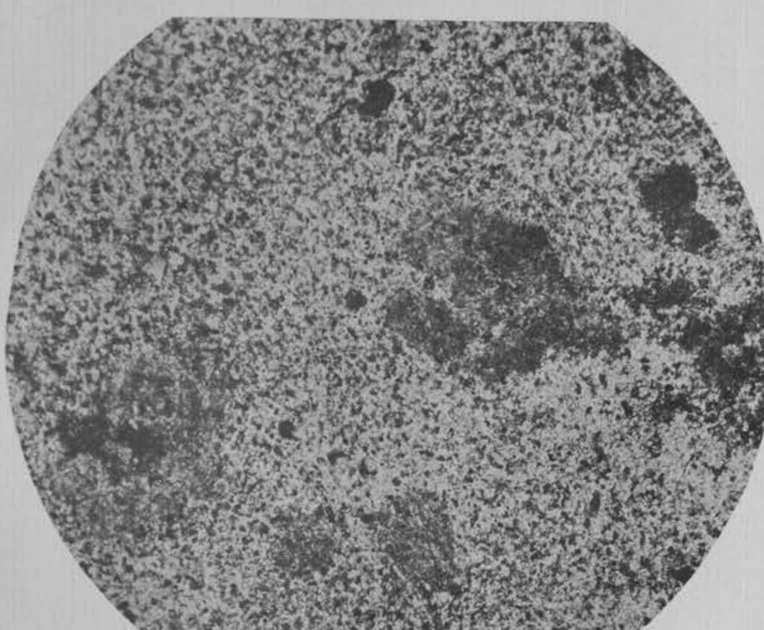

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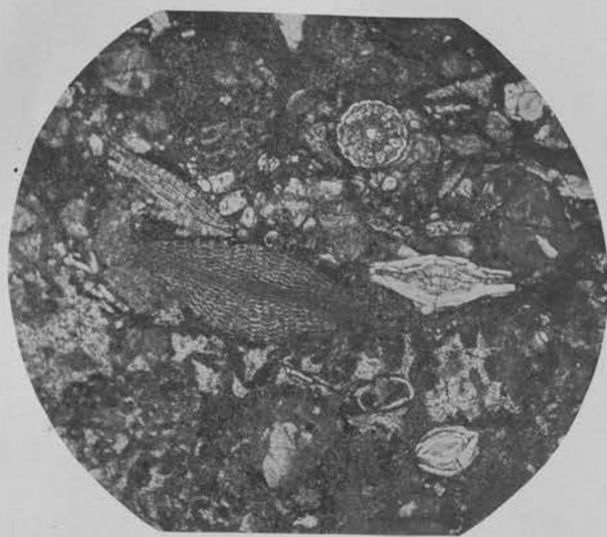
PLATE 2. ROCKS FROM SAMAR.



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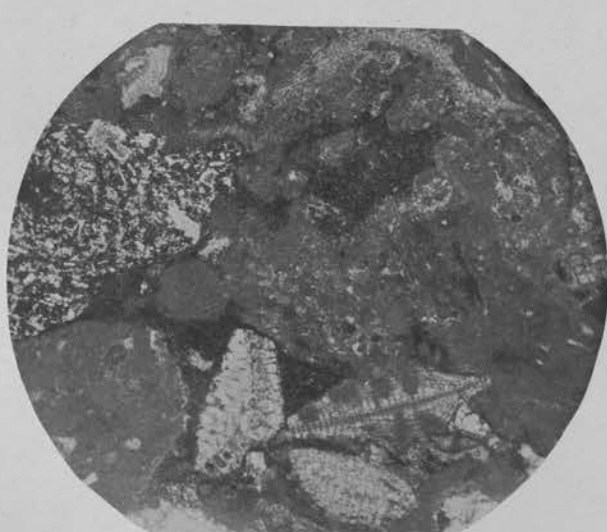

2

PLATE 3. FORAMINIFERAL ROCKS FROM SAMAR.

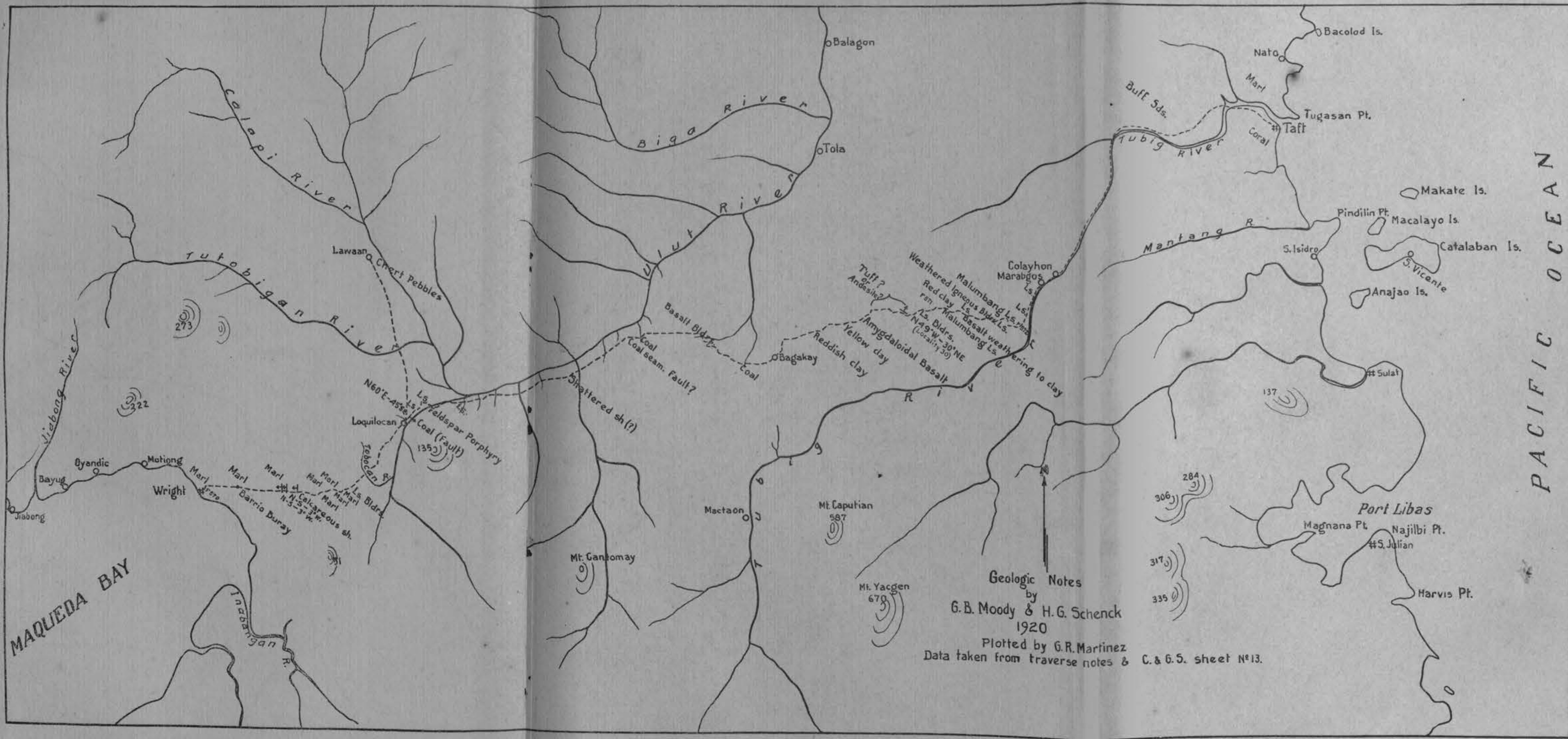

PLATE 4. TRAIL FROM WRIGHT TO TAFT, SAMAR.

PLATE 5. SAMAR, PHILIPPINE ISLANDS.

CERCOPIDES NOUVEAUX DES PHILIPPINES

Par V. LALLEMAND

Uecle, Bruxelles

APHROPHORINÆ

Clastoptera bakeri sp. nov.

Noire, sur la partie frontale du vertex de chaque côté cinq lignes blanc-jaunâtre séparées par une ligne noire médiane, à la partie inférieure du front de chaque côté une tache blanc jaunâtre; extrémité et bords du clypeus, base du rostre, hanches antérieures, mésosternum, hanches postérieures, articulations des cuisses et des tibias antérieurs et médians, une tache sur les tibias médians et deux taches à la base des épines des tibias postérieurs et les tarses postérieurs sont ocre-jaune, les élytres sont noires; en arrière de l'extrémité du clavus elles sont brunes, plus ou moins ombrées et lignées de noir et légèrement translucides; les yeux sont gris, toute la surface supérieure de l'insecte est densement ponctuée recouverte d'un fin duvet argenté peu dense; sur le pronotum se trouve une carêne longitudinale très marquée allant du bord antérieur au postérieur.

Longueur totale, 3 millimètres.

LUZON, Laguna Province, Mount Maquiling (*Baker*).

Le type se trouve dans ma collection.

Je dédie cette espèce à M. le Professeur C. F. Baker de Los Baños, le distingué hemiptérologiste.

Clovia lineolata sp. nov.

L'insecte est jaune, ligné de noir; sur le front se trouvent cinq lignes noires transversales (la cinquième est brisée en son milieu); le bord de la tête, trois bandes transversales sur le vertex et quatre sur le pronotum (les bords antérieurs et postérieurs et deux médianes) sont noirs. Les lignes noires du front constituent le commencement d'une bande qui englobe l'œil, passe sur le prothorax, borde légèrement le pronotum et se continue sur l'élytre en tachant le mesothorax (tache triangulaire). Sur l'élytre existent deux larges bandes longitudinales noire, une l'externe, dont j'ai parlé antérieurement, longe le bord externe jusqu'au milieu de sa longueur d'où elle se dirige vers

l'extrémité en pointe de l'élytre, vers la fin du tiers antérieur, sur cette ligne se trouve un petit tiret jaune. Dans la seconde moitié de l'élytre, dans la partie comprise entre la bande et le bord externe existe une tache hyaline traversée par une bande brune. La second bande s'étend du clavus jusqu'au bord apical prés de l'extrémité de la première; tout le bord interne est longé par une fine bande noire, au niveau de la pointe du clavus, elle se bifurque et englobe une cellule jaune puis se continue jusqu'à l'extrémité en pointe de l'élytre. La première bande est réunie à la seconde par une ligne noire au niveau de la nervure transversale apicale et la deuxième à la bordure noire interne au niveau de la pointe du clavus. Une courte bande noire occupe le côté du mésothorax. La partie supérieure de l'abdomen est estompée de noir; à sa partie inférieure les segments sont bordés latéralement de noirâtre, le dernier segment est bordé en arrière de noir. Chez le mâle le bord interne des sternites et la tarrière sont noirs. Toute la surface supérieure est densement et finement ponctuée et couverte d'une fine villosité jaunâtre, la tête et le pronotum sont aplatis et sur le même plan. L'écusson est plus long que large, les élytres sont terminés en pointe légèrement arrondie. Le front assez aplati, peu convexe, montre à sa partie supérieure cinq à six stries transversales.

Longueur, 8 millimètres.

LUZON, Laguna Province, Los Baños (*Baker*).

Le type se trouve dans ma collection.

Flosshilda translucida sp. nov.

L'insecte est presque entièrement jaune, le vertex et le pronotum, sur son disque, sont légèrement estompés de brun et les épines des tarses sont noires; les élytres sont translucides sauf dans le tiers antéro-interne. Les ocelles sont très proches l'un de l'autre séparés par une fine carêne, la tête est plus courte et un peu plus étroite que le pronotum, le front est lisse et convexe. Le bord antérieur de la tête est en angle obtus; sur l'écusson se voit une grande fossette médiane longitudinale et à sa base deux autres petites fossettes.

Longueur, 6 millimètres.

LUZON, Laguna Province, Los Baños (*Baker*).

Le type se trouve dans ma collection.

Flosshilda furcata sp. nov.

La tête est noire, sauf une tache de chaque côté entre les yeux et la partie frontale du vertex et une troisième entre les ocelles

qui sont de même couleur blanc-jaunâtre; pronotum noir, écusson noir également sauf sa base et sa pointe qui sont blanc-jaunâtres. Les deux tiers antérieurs des élytres sont noirs et le tiers postérieur hyalin, sur les deux tiers antérieurs le bord interne dans sa partie longeant le pronotum et le bord externe dans la moitié antérieure sont jaunâtres, sur la partie hyaline trois bandes noires partent du milieu de l'élytre et du bord postérieur de la partie noire non translucide, la première, droite, aboutit au bord interne en arrière de la pointe du clavus, la deuxième, courbe, aboutit au bord postérieur et le suit quelque peu, la troisième, courbe également, aboutit à l'extrémité du bord externe. Le rostre, le mésothorax, les tibias et les tarses médians et postérieurs sont jaunâtres, les cuisses postérieurs sont jaunâtres avec des taches brunes; les segments abdominaux sont noirs bordés de jaune. La surface supérieure de l'insecte est densement et finement ponctuée et recouverte d'une fine et dense villosité blanc-jaunâtre. Les ocelles sont très proches l'un de l'autre séparés par une fine carêne longitudinale; sur le pronotum est un sillon longitudinal plus marqué dans la partie postérieure.

Longueur, 5 millimètres.

LUZON, Laguna Province, Mount Maquiling (*Baker*).

Le type se trouve dans ma collection.

Flosshilda crassipes var. striata var. nov.

Diffère de l'espèce par les caractères suivants: L'écusson est jaune-rougeâtre avec deux taches triangulaires à la base et une ligne longitudinale médiane noires; sur les élytres se trouve une seconde tache triangulaire hyaline à la fin du tiers antérieur du bord externe et sur le clavus une ligne médiane transversale allant d'un bord à l'autre et en arrière de celle-ci deux taches transversales une à chacun des bords et une ligne longitudinale un peu courbe suivant la nervure, jaune-rougeâtre; sur certains exemplaires moins bien marquées les deux taches postérieures peuvent manquer; la partie postérieure des élytres est plus ou moins translucide, et le dégré de translucidité varie d'un insecte à l'autre; à la partie postérieure de la suture clavo-coriale et chevauchant sur le clavus et le corium se trouve une tache plus claire, plus translucide que la partie des élytres qui suit.

Longueur, 4 mm. 5.

LUZON, Laguna Province, Mount Maquiling (*Baker*).

Le type se trouve dans ma collection.

Poophilus elongatus sp. nov.

L'insecte est brun; le front est un peu plus foncé, les ailes sont morderées avec une trés légère teinte rougeâtre à leur extrémité, les tarses et les épines sont noires. La partie supérieure de la tête est à peu près deux fois aussi large que longue en son milieu, elle est aplatie. Les ocelles sont légèrement plus éloignés l'un de l'autre que des yeux, elle est traversée par un sillon longitudinal qui se prolonge sur le pronotum, au milieu de celui-ci le sillon cesse et est continué par une fine carêne. Le pronotum est bombé et déclive antérieurement, plus large que long, son bord postérieur est concave, sa surface est densement et finement ponctuée. L'écusson est plan, triangulaire, un peu plus long que large. Les élytres sont trois fois aussi longues que larges, elles se terminent en pointe plus ou moins arrondie. Le bord interne est droit jusqu'à la pointe du clavus. Le rostre s'étend jusque entre les hanches médianes. Les tibias postérieurs ont deux fortes épines, toute la surface du corps et des élytres est recouverte d'une fine et dense villosité jaunâtre.

Longueur du corps, 17 millimètres; élytres, longueur, 14; largeur, 4 mm. 5.

LUZON, Manila.

Le type se trouve dans ma collection.

CERCOPINÆ

Poeciloterpa nigrilimbata Stål var. **unicolor** var. nov.

Sauf les extrémités des tarses et des épines qui sont noires et les yeux quelque peu ombrés de noir, l'insecte est entièrement rouge brique; le mésothorax est un peu plus clair tirant légèrement sur le jaune.

Longueur, 6 millimètres.

LUZON, Laguna Province, Los Baños (*Baker*).

Le type se trouve dans ma collection.

Poeciloptera nigrilumbata Stål var. **minuta** var. nov.

Cette variété est comme l'espèce, rouge brique, les tarses et les extrémités des épines sont noirs, à l'extrémité du clavus se trouve une petite tache brune et un peu plus en arrière sur le corium existe une bande brune transversale allant d'un bord à l'autre et brisée en son milieu.

Cette variété diffère surtout de l'espèce par sa taille menue.

Longeur, 3 mm. 5.

LUZON, Laguna Province, Mount Maquiling (*Baker*).

Le type se trouve dans ma collection.

Trichoscarta luteomaculata sp. nov.

Tête, pronotum et écusson noir-verdâtre, à reflets métalliques; les yeux sont gris tachés de brun; sur la partie médiane du front se trouve une tache jaune. Elytres brun-acajou, sur le clavus se montre une bande jaune le long de son bord interne et partant de la base, au niveau de la partie retrécie de l'écusson, elle se rétrécit et se dirige en dedans et en arrière jusque la suture clavo-coriale; sur le corium existent trois petites taches et une bande oranges, la première près du bord externe à l'extrémité du tiers antérieur, la deuxiéme près de la suture clavo-coriale non loin de l'extrémité de la bande jaune du clavus, la troisième au même niveau sur le radius à sa bifurcation, la bande se trouve devant la partie réticulée. Le thorax et l'abdomen sont noirs. Les pattes sont brunes, l'articulation des cuisses aux hanches postérieures est jaunâtre, les tarses postérieurs sont jaune-brun, le front est bombé, vu de côté, il montre un angle obtus, tandis que vu de face il présente deux protubérances émoussées, courtes et coniques, séparées par un sillon longitudinal, le rostre est long, il atteint les hanches postérieures. Le pronotum transversalement ponctué, porte une carêne longitudinale, son bord postérieur est concave et arrondi. L'écusson est plus long que large à sa base; il est prolongé en une longue pointe, transversalement striée. Les élytres sont recouvertes d'une villosité assez longue et brillante. Le mésothorax ne porte pas de protubérance. Les élytres sont deux fois et demi aussi longues que larges; le cubitus et le radius sont réunis sur environ les deux cinquiemes antérieurs de l'élytre.

Longueur, 16 millimètres.

PALAWAN (*Noualhier*).

Le type se trouve dans la collection du Musée de Paris.

Serapita philippinensis sp. nov.

Vertex, pronotum brun-chocolat avec un léger reflet violet; écusson violet foncé à extrémité jaune; les élytres noirâtres deviennent brun foncé à leur partie apicale, leur bord interne, jusqu'à l'extrémité de l'écusson, est étroitement jaune-brun, trois taches de même couleur se trouvent sur le corium, une sur le rameau commun du médian et du cubitus réunis, à la fin d'un quatrieme antérieur, et les deux autres transversales en avant de la partie reticulée, une près du bord externe et l'autre sur le cubitus près de l'extrémité du clavus. Les ailes sont enfumées. Le front est brun-clair; les yeux sont gris clair; le thorax et l'abdomen sont noirâtres; le rostre et les pattes sont d'un brun

plus ou moins jaunâtre, les tarses sont plus nettement jaunâtres. Le pronotum rugueux, à rides transversales, porte une carêne médiane très nette et son bord postérieur est concave et arrondi; l'écusson est grand, transversalement strié et en son milieu creusé en une large fossette; sur le tiers antérieur des élytres, le médian et le cubitus sont réunis en un tronc commun. Le bord postérieur [1] du mesothorax est foliacé et la protubérance du mésothorax n'est pas conique mais un peu aplatie.

Longueur, 1 mm. 5.

LUZON, Laguna Province, Los Baños (*Baker*).

Le type se trouve dans la collection de Baker et dans la mienne.

Serapita montis sp. nov.

Tête jaunâtre, pronotum, de même couleur, brunâtre sur la partie postérieure de son disque, une tache brune rectangulaire derrière le bord antérieur. Les élytres brun-jaunâtre, sont jaunes à leur base et au bord interne le long du pronotum, elles ont deux taches jaunes au bord externe, une à la fin du tiers antérieur et l'autre à la fin du second tiers. Tête, thorax, pattes et abdomen, jaunâtres; ailes d'un brun-jaunâtre clair. Ocelles á égale distance l'un de l'autre et des yeux. Le pronotum fort convexe, est densement ponctuée à carêne médiane très marquée, ses angles scapulaires sont un peu dilatés comme chez *Leptataspis angulosa* Stål, son bord postérieur est concave. L'écusson grand, fortement et transversalement strié, montre à sa partie médiane une assez large fossette. Sur les élytres, le médian et le cubitus sont soudés sur le tiers antérieur. Les protubérances du mésothorax sont transversales, très légèrement aplaties d'avant en arrière, le bord postérieur est foliacé.

Longueur, 14 millimètres.

LUZON, Mount Banahao (*Baker*).

Le type se trouve dans ma collection.

[1] Dans mon travail sur les Cercopides paru dans les Genera Insectorum Fasc. 143, j'ai écrit plusieurs fois par erreur "bord *antérieur* du mésothorax," c'est *postérieur* qu'il faut lire.

IDENTIFICATION OF BACTERIA PATHOGENIC TO PLANTS PREVIOUSLY REPORTED FROM THE PHILIPPPINE ISLANDS

By Colin G. Welles

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The study of phytobacteriology has not been pursued to any extent as yet in the Philippine Islands. The bacterial diseases that have been reported have been identified, with a few exceptions, mainly through symptoms, the cultural and morphological studies having been omitted.

The present paper is the first of a series in which all known bacterial organisms, pathogenic to plants found in the Philippine Islands, will be briefly described. In this paper *Bacterium solanacearum* E. F. Sm., *Pseudomonas phaseoli* E. F. Sm., *Bacterium malvacearum* E. F. Sm., and *Bacillus nelliae* sp. nov. are reported upon.

REVIEW OF LITERATURE

A bacterial wilt of solanaceous plants, especially of tobacco (*Nicotiana tabacum* Linn.) has been observed to be very destructive locally. Reinking(5) examined tissues of wilted tobacco, eggplant, and tomato plants and found the vascular elements entirely clogged with bacteria which, in advanced stages, frequently invaded the parenchymatous tissue. From the abovementioned observations the disease was reported as solanaceous wilt and was said to be caused by *Bacillus solanacearum* E. F. Sm. The description of the symptoms is similar to that given by Smith(7) and by Garner, Wolf, and Moss.(3)

Bean blight, common in the United States, caused by *Pseudomonas phaseoli* E. F. Sm., was also reported by Reinking.(5) The disease was described as follows:

> This well-known disease is * * * destructive on *Phaseolus vulgaris* Linn. and on *Phaseolus lunatus* Linn. Leaves, stems, and pods are attacked. Characteristic, irregular brownish spots with water-soaked edges are produced on the leaves. * * * The organism attacks pods, forming a characteristic watery spot, and also works down into the seed, thus infecting the latter.

On microscopic examination Reinking found the organisms to be abundant in leaf veins and exuding from those elements in mounted sections. No studies were made with pure cultures of the organism.

The above description of symptoms is very similar to that of Burkholder.(1)

Reinking(5) reported the presence of angular leaf spot of cotton caused by *Bacterium malvacearum* E. F. Sm. He says of this disease:

> The disease is present on leaf, stem, and fruit. On the leaf the characteristic spots are from 1 to 4 millimeters in diameter; they are angular with brownish centers bordered with light brown to yellow. Young spots are similar and have a water-soaked appearance. * * * The disease may be evident on the tender stalks in the form of blackened cankerous patches. On the bolls, at first, minute water-soaked spots are produced, which later may run together, producing sunken brownish or reddish brown blotches.

Furthermore, Reinking states that "The causal organism is a bacterium that produces a yellow pigment in pure culture." No proof is given to show that the organism forming the yellow pigment is the pathogenic or the saprophytic one commonly associated with the disease.

The descriptions of the symptoms of the disease compare favorably with those of Rolfs,(6) McCall,(4) and Faulwetter.(2) While the descriptions of symptoms are valuable they do not furnish proof of the identity of the causal organism. Because of the accuracy of the preceding descriptions they will suffice for the present paper. The physiological and morphological studies carried on with the various organisms are here presented briefly. In each case inoculations under controlled conditions were carried out to prove the pathogenicity of the organisms.

BACTERIUM (BACILLUS) SOLANACEARUM E. F. Smith.

The organism was isolated from wilted tobacco, eggplant, and tomato plants. Isolations were made by crushing the material, after treatment for one minute in corrosive sublimate, 1 to 1,000, in sterile water, and plating directly in nutrient agar.

The organism stains readily with the common aniline dyes and shows no irregularity in taking the stain. The cells measure from 0.8 to 1.2 μ in length.

According to Smith(7, 10) the cells measure 0.6 to 1.0 μ in length with several peritrichous flagella.

The artificial media used were titrated to + 10 Fuller's scale.

Nutrient agar slant.—After twenty-four hours, growth was abundant, filiform, convex, dull, smooth, opaque, dirty white, without odor, and slimy. After ten days the growth became brownish, with a slight brownish coloring of the agar. According to Smith (7, 10) the growth was white, smooth, moist, glistening, becoming yellowish brown to brown and the agar was stained brown.

Nutrient agar colonies.—After twenty-four hours, rapid growth had taken place at 26° to 28° C., with colonies round, smooth, convex, entire-edged, and finely granular internal structure.

Potato slant.—After twenty-four hours, growth was moderate, filiform, slightly convex, dull, smooth, brownish, no odor, and slimy. After a week, the growth became a deep brown. According to Smith (7, 10) the growth was dirty white becoming brownish to smoke-black.

Sugar media.—Neither gas nor acid was formed in saccharose, dextrose, lactose, or mannite. Smith (10) reports that acid and gas are not produced in common sugar media.

Nutrient broth.—After twenty-four hours, growth was abundant, surface growth was more or less flocculent, becoming evenly distributed throughout the medium on agitation. Clouding was moderate, without odor. A slight sediment was formed and an alkaline reaction was obtained. According to Smith (7, 10) zoogloea developed in the upper layer, giving the medium uniform turbidity on agitation. An alkaline reaction developed.

PSEUDOMONAS PHASEOLI E. F. Smith.

The organism was isolated from diseased bean leaves (*Phaseolus vulgaris* Linn.) by crushing the material in sterile water and plating directly in potato agar.

The bacterial cells stain readily with the common aniline dyes and appear as short rods with rounded ends. Smith (8) states that "*Bacillus phaseoli* E. F. S. is a short rod with rounded ends, * * * motile in early stages of growth."

All artificial media were titrated to + 10 Fuller's scale.

Nutrient agar slant.—After twenty-four hours, growth was moderate, entire-edged, convex, glistening, smooth, opaque, yellow (chrome), with an odor of slight putrefaction, and of slimy consistency.

Potato agar colonies.—After three days, growth was moderate and colonies were round, smooth, convex, edge entire, internal

structure finely granular. The colonies were yellow with hyaline center. The starch was reduced by the action of the bacteria. Smith (9) states that copious and prolonged growth occurred, covering the potato plug and developing in the water, and within a few weeks the starch was hydrolized.

Nutrient broth.—After twenty-four hours, there was a slight, tough surface growth, which sank on agitation. There was slight, even cloudiness throughout the medium.

Lactose broth.—There was slight flocculent precipitate with no acid and no gas.

Dextrose broth.—There was considerable surface growth. No gas was produced; the reaction was strongly acid.

Saccharose broth.—There was a moderate surface film not breaking up on agitation. No gas was produced.

Mannite broth.—Flocculent precipitate developed in the medium. There was no gas, and the reaction was slightly acid. Smith (9) states that on agars containing various sugars growth was copious.

Glycerine broth.—There was a flocculent growth and the medium was heavily clouded. No gas was produced, and the reaction was slightly acid.

Nitrate broth.—There was a moderate flocculent growth. Neither gas nor acid was produced, and there was no reduction in four weeks.

Nothing has been published, to my knowledge, giving the complete growth characters of this organism. There have been a few reports where partial culture work has been given. As the descriptive chart of the Society of American Bacteriologists is being followed in this paper to a large extent, the cultural characters in Smith's famous paper of 1901 permit of very little comparison. However, from the symptoms and the checking of a few comparative factors the organisms as well as the diseases seem identical.

BACTERIUM MALVACEARUM E. F. Smith.

The organism was isolated from young, watery lesions on leaves of cotton, by the method given above. The cells stain readily with the common aniline dyes, showing no irregularity in taking the stain.

Nutrient agar colonies.—After twenty-four hours, growth was moderate (26° to 28° C.). The colonies were round, smooth, convex, entire-edged, with internal structure finely granular, with

a diameter of 1 to 3 μ. A pale yellow pigment was produced. According to Rolfs,(6) the amount of growth appeared on different sugar media in the order named; dextrin, mannite, maltose, and dextrose, and a pale yellow pigment was produced on agars.

Nutrient agar slant.—After twenty-four hours, growth was moderate, filiform, raised, glistening, smooth, opaque, pale yellow, odor of putrefaction, and a slightly slimy consistency.

Nutrient broth.—There was a thin surface growth. Culture was moderate and uniformly clouded and no sediment was formed.

Lactose broth.—A light surface growth appeared.

Dextrose broth.—There was moderate surface growth, with no gas, and a strongly acid reaction.

Saccharose broth.—There was a surface growth and a moderate, uniform clouding of the liquid. No gas was formed.

Mannite broth.—No gas was formed, and the reaction was strongly acid.

Glycerine broth.—There was no gas and no acid. Clouding was slight. Rolfs(6) states that growth was poor on glycerine agar.

The description of the organism by Rolfs checks with the organism just described, excepting that no difference in degree of growth was observed on the various sugar media. The nonpathogenic organism producing the bright yellow pigment, mentioned by Rolfs, was frequently encountered in isolations, and it caused considerable trouble as it appeared before the pathogenic pale yellow organism.

BACTERIAL WILT OF PARSLEY

The bacterial wilt of parsley, which has been found to be caused by a new species of bacteria, was for several seasons believed to be caused by *Bacillus solanacearum* E. F. Sm. The vascular bundles, on microscopic examination, appeared to be packed with bacteria, and the whole behavior of the parasitized plants was precisely like that of solanaceous plants parasitized by *Bacillus solanacearum* E. F. Sm. A further substantiation of this diagnosis was that the diseased plants were found on soil which was known to be heavily infested with the solanaceous wilt organism. On making physiological studies, the organism proved to be entirely different from *Bacterium solanacearum* E. F. Sm.

BACILLUS NELLIAE sp. nov.

The organisms are short rods with rounded ends, 0.83 to 2.27 μ by 0.37 to 0.50 μ. They stain readily with all common aniline dyes, and show no irregularities in taking the stain. The thermal death point lies between 53° and 54°. Three to seven peritrichous flagella have been demonstrated. The artificial media were titrated to + 10 Fuller's scale.

Nutrient agar stroke.—After twenty-four hours, growth was moderate, filiform, flat, more or less glistening, contoured, whitish by transmitted and translucent by direct light, without odor, and of a slimy consistency. With age the culture became irregularly raised.

Nutrient agar colonies.—Surface colonies after twenty-four hours were round, slightly concentrically ringed, raised, finely granular in structure, and with an entire edge.

Potato agar slant.—Growth was moderate, spreading, with yellow pigment, flat, smooth, odorless, and of viscid consistency.

Nutrient agar stab.—There was moderate arborescent growth, and considerable surface growth.

Potato-glucose agar stroke.—After twenty-four hours, growth was abundant, filiform, slightly convex, glistening, translucent, becoming opaque, and of a viscid consistency. Gas was formed under the medium forcing the latter up in the tube.

Dextrose broth.—Acid and gas were produced.

Lactose broth.—Gas was produced. The reaction was slightly acid.

Galactose broth.—Gas was formed. A strong acid reaction was obtained.

Saccharose broth.—Gas was formed, and the reaction was strongly acid.

Mannite broth.—Gas and a strongly acid reaction resulted.

Glycerine broth.—Neither gas nor acid was formed. Growth took place in the closed and open arms of fermentation tubes.

Nitrate broth.—There was no reduction; neither gas nor acid was produced.

Toleration of sodium chloride.—Growth occurred at 8 per cent concentration.

Effect of sunlight.—Twenty minutes' exposure reduced but did not inhibit growth.

LITERATURE CITED

1. BURKHOLDER, WALTER H. Bean diseases in New York State in 1916. Abs. Phytopath. 7 (1917) 61.

2. FAULWETTER, R. C. The angular leaf spot of cotton. Bull. S. C. Agr. Exp. Sta. **198** (1919) 1–29.
3. GARNER, W. W.; WOLF, F. A.; and MOSS, E. G. The control of tobacco wilt in the fluecured district. Bull. U. S. Dept. Agr. **562** (1917).
4. MCCALL, J. STEWART. Bacterial blight of cotton. Trop. Agr. **34** (1910) 373, 374.
5. REINKING, OTTO A. Philippine economic-plant diseases. Philip. Journ. Sci. § A **13** (1918) 165–274.
6. ROLFS, F. M. Angular leaf spot of cotton. Bull. S. C. Agr. Exp. Sta. **184** (1915) 1–30.
7. SMITH, ERWIN F. A bacterial disease of the tomato, eggplant and Irish potato. Bull. U. S. Dept. Agr. Div. Veg. Physiol. & Path. **12** (1896) 1–26.
8. SMITH, ERWIN F. Description of Bacillus phaseoli sp. nov. with some remarks on related species. Proc. Am. Assoc. Adv. Sci. 46th meeting 1897 (1898) 288–290.
9. SMITH, ERWIN F. The cultural characters of Pseudomonas hyacinthi, Pseudomonas campestris, Pseudomonas phaseoli, and Pseudomonas stewarti—four one-flagellate bacteria parasitic on plants. Bull. U. S. Dept. Agr. Div. Veg. Physiol. & Path. **28** (1901) 153.
10. SMITH, ERWIN F. Bacteria in relation to plant diseases. **3** (1914) 174–206.

SOME RESULTS WITH INTELLIGENCE TESTS IN THE PHILIPPINE ISLANDS

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EIGHT TEXT FIGURES

The present paper consists of three parts. Part one gives the results of the application of the Otis group intelligence scale to 1,000 male and 752 female teachers in Tayabas, Batangas, Laguna, and Rizal Provinces. Part two gives the results of the same scale applied to 166 male and 59 female teachers from all parts of the Philippines, gathered in convention at Baguio. Part three gives the results of the application of the Yerkes point scale to 146 boys and 29 girls, many of them of mixed blood, in the Palawan Provincial School at Cuyo.

PART ONE

The Otis group intelligence scale was devised by Dr. Arthur S. Otis, of Leland Stanford Junior University, and was copyrighted by the World Book Company in 1919. It was one of the first and most satisfactory scales devised for testing subjects in groups. It is very similar in form to the Alpha examination adopted by the United States Army later.[1]

The Otis scale tests chiefly the higher mental processes, such as controlled association, analysis, logical judgment, synthesis, and generalization. Comprehension of language (English), memory, and imagination are, of course, also involved. Incident to the group method, in which the correct response (to be underlined by the subject) to each problem is suggested along with several incorrect responses—which makes possible a rapid scoring of the examination sheets by means of stencils—is the important element of recognition, but what Terman says of recognition in reading probably applies here:

> Recognition is for the most part an associative process. Rapid and accurate association will mean ready recognition of the printed form.[2]

[1] Yoakum and Yerkes, Army Mental Tests. New York (1920) 2.
[2] Terman, The Measurement of Intelligence. New York (1916) 265.

Table 1 outlines the principal mental functions involved in meeting the requirements in each separate test in the scale.

TABLE 1.—*Mental functions involved in Otis scale test.*

Test No.	Requirement.	Principal mental functions involved.
1	Following directions	Comprehension of language, reaction according to instructions, inhibition of interfering associations and perseverations.
2	Giving opposites	Controlled association—which lies at the basis of the reasoning process.
3	Arranging disarranged sentences.	Ideation, vocabulary, memory, analysis, logical integrity of the association process.
4	Interpreting proverbs	Generalization, language.
5	Solving arithmetical problems.	Arithmetical reasoning, attention.
6	Discriminating between geometric figures.	Visual discrimination, comparison, attention, comprehension of language.
7	Completing analogies	Logical judgment and analysis.
8	Giving similarities	Controlled association—"Thinking means essentially the association of ideas on the basis of differences and similarities." [a]
9	Completing a narrative	Synthesizing ability—"Intelligence is essentially a combinative activity," [b] memory, association.
10	Memory	Logical or substance memory, immediate memory for ideas, language, "Language growth mirrors the entire mental development . . . it is the *sine qua non* of conceptual thinking," [c] suggestibility.

[a] Terman, The Measurement of Intelligence. New York (1916) 202.
[b] Whipple, Manual of Mental and Physical Tests. Baltimore (1914) 649.
[c] Terman, op. cit. 265.

Table 2 shows the total number of scores made by the provincial teachers, and the number of men and women making each score. The average score for the men is 77.0 and for the women 70.9.

Fig. 1 shows graphically the data that are recorded in Table 2. The class interval is ten points. The regularity of the curves for the men and the women, and the fairly constant relation between the two, indicate that enough data were obtained to give representative results.

Table 3 gives the average scores made by the teachers in the different provinces, which are all Tagalog.

Prof. H. Otley Beyer, of the University of the Philippines, says the following concerning the Tagalog group of Philippine peoples:

Number, 1,789,049; the second largest Philippine group and the highest in cultural development. *Loc.:* The great majority of the Tagalogs are found in Luzon, where they form the greater part of the population in the following provinces: Tayabas, Batangas, Cavite, Laguna, Rizal, Manila city, Bataan, Bulacan, and Nueva Ecija. Considerable numbers are also

TABLE 2.—*Showing all scores made by the provincial teachers and the number of men and women making them.*

[B, Batangas; L, Laguna; R, Rizal; T, Tayabas.]

Score.	Number.		Score.	Number.		Score.	Number.	
	Male.	Female.		Male.	Female.		Male.	Female.
3	B 1		61	14	14	108	7	6
10	L 1		62	14	20	109	6	5
13		T 1	63	11	9	110	7	2
15	L 1	R 1	64	16	13	111	4	2
16	B 1		65	12	11	112	3	1
18	L 1	T 1	66	18	10	113	4	2
20		R,T 2	67	16	13	114	6	3
21	2	4	68	17	18	115	5	3
22	2	1	69	12	11	116	8	
23	1	2	70	14	10	117	6	2
24	1	3	71	21	16	118	1	5
25	1		72	16	10	119	7	2
26	3	1	73	16	2	120	2	
27	3	2	74	18	23	121	3	1
28	1	3	75	26	8	122	9	3
29	2	4	76	14	7	123	2	1
30	3	4	77	15	11	124	2	2
31	8	8	78	16	8	125	2	2
32	2	4	79	10	12	126	4	
33	4	4	80	18	11	127	2	1
34	7	4	81	15	12	128	3	
35	7	2	82	18	14	129		2
36	3	7	83	9	10	130	1	5
37	3	6	84	12	11	131	1	1
38	7	3	85	15	6	132	2	
39	3	4	86	9	11	133	1	1
40	5	5	87	15	12	134	3	1
41	5	6	88	12	2	136	2	
42	14	6	89	15	8	137	5	
43	6	6	90	13	9	138	1	
44	11	7	91	8	5	139	2	
45	3	8	92	8	7	140	1	
46	7	17	93	10	6	141	1	
47	8	9	94	13	5	142	2	
48	10	8	95	16	9	144		L 1
49	9	7	96	8	8	147	T,B 2	
50	13	12	97	15	4	149	T 1	L 1
51	16	10	98	9	5	150	T 1	
52	7	8	99	9	11	151		R 1
53	7	11	100	9	6	153	R 1	T 1
54	9	13	101	15	9	154		L 1
55	11	10	102	7	4	156	L 1	
56	14	7	103	2	3	161	L 1	
57	12	10	104	6	3	163		L 1
58	13	14	105	8	6	167	R 1	
59	11	11	106	7	4	171		L 1
60	16	13	107	7	3	Total	1,000	752

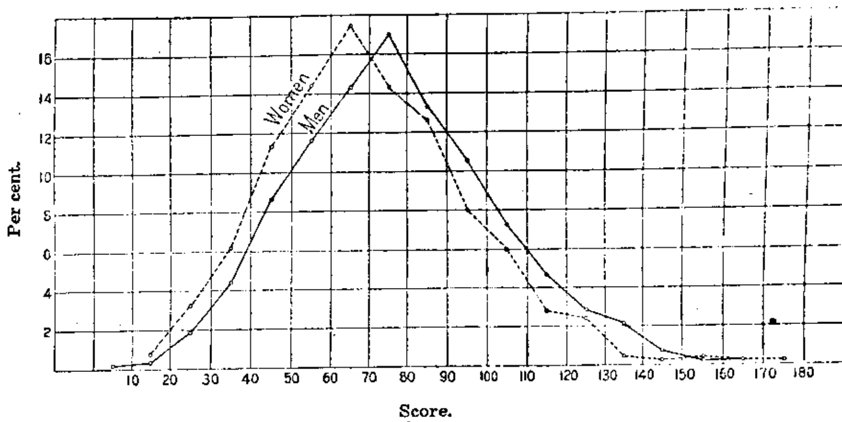

FIG. 1. The percentile distribution of scores for men and women—provincial group.

TABLE 3.—*Showing the average scores made by teachers in the several Tagalog provinces.*

Province.	Number.	1	2	3	4	5	6	7	8	9	10	Total.
MEN.												
Rizal	152	8.4	9.7	10.8	3.7	9.9	6.4	7.4	7.3	8.2	11.0	82.8
Tayabas	366	7.9	11.4	8.4	4.7	8.7	6.0	5.7	6.1	8.8	9.5	77.2
Laguna	257	7.6	9.6	8.2	4.0	9.3	5.9	7.2	6.6	6.8	10.0	75.2
Batangas	225	8.1	9.1	8.3	3.3	10.3	6.3	7.1	6.8	6.4	9.4	75.1
Total	1,000	7.9	10.2	8.7	4.0	9.4	6.1	6.7	6.6	7.6	9.8	77.0
WOMEN.												
Tayabas	176	7.4	11.3	9.0	4.3	7.3	5.5	5.1	5.3	8.6	9.4	73.2
Laguna	209	7.4	9.4	8.0	3.5	7.9	5.6	6.0	5.9	7.7	9.9	71.3
Rizal	203	7.5	8.0	8.7	2.3	8.4	5.6	6.7	7.1	6.7	9.8	70.3
Batangas	164	7.5	8.4	6.9	2.6	8.4	5.6	6.5	6.6	5.8	10.0	68.3
Total	752	7.5	9.3	8.2	3.2	8.0	5.6	6.1	6.2	7.2	9.6	70.9

found in northern Camarines, Tarlac, and southern Zambales. In addition to Luzon, the island of Marinduque is wholly Tagalog, while Masbate is partly so, and the coastal region of the northern two-thirds of Mindoro. A few individuals are to be found in practically every province of the Islands, while numbers have emigrated to the United States, Hawaii, Japan, the China Coast, and other foreign lands. *Char.:* Christian; and possessing the general Spanish-Filipino civilization of the lowland people. In a majority of the Tagalog provinces the predominating physical type is a Malay blend with the short and tall Mongol elements exceedingly prominent. The chief exceptions are the provinces of Batangas, Cavite, and a few minor localities, where the Indonesian element is most in evidence. . . The people of the coastal regions are much mixed and tall types predominate, while those of the interior are more uniform and short types are common.[8]

[8] Beyer, H. O., Population of the Philippine Islands in 1916. Manila, Philippine Education Co. (1917) 70–71.

It should be understood that Beyer recognizes the following racial types in the Philippine Islands:

Three dwarf types.—(1) The aboriginal Negrito—short, slender, very dark, frizzly-haired, body hairless, face Negroid; (2) a very old Australoid Ainu mixture—short, stocky, light, hairy, early gray, face Caucasian; and (3) the Proto-Malay—short, stocky, dark, body hairless, face Mongoloid, nose short and immobile, eyes prominent, third lid, wide apart.

Three tall types.—(1) The Malay—slender, brown, face flat and oval, probably an early and progressive Chinese-Indonesian mixture; (2) the Indonesians, which are divided into three subtypes—(A) tall, slender, light, Caucasian features; (B) tall, heavier, dark, Semitic features; and (C) tall, heavy, very dark, Negroid features; and (3) the Papuan—true Negro type.[4]

Table 3 shows some exceedingly interesting provincial differences. There is a difference of twelve points in the average total score for the men and women of Rizal, whereas the sex difference in the other provinces is much less.

There exist some striking differences in physical type between the men and the women of the same groups in various localities in the Philippines. Among the Ifugaos, for example, the men belong in general to the Malay blend type, while the women belong clearly to the Proto-Malay type. It seems, in other words, that the women represent in physical type the older mountain people who were conquered by the later Malay invaders, who imposed upon them their general culture, and their physical type upon their sons, but who could produce apparently no change in the appearance of the women and their daughters in some sixteen centuries.

The same thing is probably true in Rizal. At one time there existed a great Chinese settlement in Mariquina Valley. Now, possibly not only physically, but mentally, the women represent the older, more primitive type of the province, while the men represent the more recent and the more intelligent Chinese element.

Tayabas ranks most consistently high for both men and women. Tayabas was but lightly populated when the Spaniards came to the Islands in the sixteenth century. Many of the present inhabitants and their descendants emigrated within the last one hundred years from Laguna, Bulacan, and Nueva Ecija. The people of Tayabas represent, therefore, a progressive and venturesome people.

[4] See Beyer's article in The Census of the Philippine Islands for 1918 2 (1921) 907–957.

The prevalent type in Laguna is the tall, light Malay blend. There has been considerable intermixture with Chinese, and some Spanish intermixture.

The Batangas teachers scored lowest. The Batangas type is a Malay blend, but with the Indonesian B element very prominent. There has been less intermixture with foreign blood than in the other provinces.

Table 4 gives the averages for these teachers taken in groups of educational attainment. The figures are significant.

TABLE 4.—*Showing average scores of the provincial teachers taken in groups of educational attainment.*

[Q. C. D., Quartile coefficient of dispersion.]

Group.	Men.			Women.		
	Number.	Score.	Q. C. D.	Number.	Score.	Q. C. D.
Below seventh grade	50	56.9	0.28	53	53.4	0.30
Intermediate graduates	509	70.5	0.16	498	69.1	0.25
First-year high school and normal school	196	73.5	0.25	125	70.8	0.21
Second-year high school and normal school	83	85.6	0.21	39	85.5	0.19
Third-year high school and normal school	38	93.4	0.13	6	95.0	0.19
Fourth-year and graduate high school	83	103.0	0.16	23	109.3	0.21
Fourth-year and graduate normal school	28	115.6	0.16	88	113.6	0.16
College graduates and undergraduates	13	110.5	0.17			
Total	1,000			752		

It must not be forgotten that the Otis scale is an intelligence scale. It is not a test of knowledge.

> Intelligence is the capacity of the mind; and knowledge is the raw material that is put into the mind.[5]

Stern says:

> The tests do actually reach and discover the general developmental conditions of intelligence and not mere fragments of knowledge and attainments acquired by chance.[6]

Terman says that school instruction is impotent to neutralize individual differences in native endowment.[7] Yerkes, in a study of the intelligence of university students and of mill operatives, in which he found the former superior, says:

[5] Platt, R. H., Measuring minds, World's Work (Sept. 1920).

[6] Stern, Psychological Methods of Testing Intelligence. Baltimore (1914) 49.

[7] Terman, The Measurement of Intelligence. New York (1916) 116.

It seems extremely improbable that this superiority is in any considerable measure due to higher education.[8]

It would be wrong to affirm that schooling has no influence at all upon the intelligence score, especially in the case of Filipinos who are given the test in the English language; for, although the Filipinos in question speak English and teach in English schools, they are, of course, less familiar with the language than American teachers. However, it will be shown later that this influence must not be overemphasized even in this case. A very considerable difference in average intelligence will be noted between seventh-grade and college graduates (see Table 4). It is much more likely that the teachers of lower educational attainments would have been unable to continue their education in the higher classes successfully. The C, or average grade of intelligence, in this case represented by a score from 52 to 81, "is rarely capable of finishing a high school course."[9]

The large gap between the average score of the teachers who had completed the intermediate school and those who had completed the first-year high-school course—73.5 and 85.6, boys only (teachers in the Bureau of Education rate their "attainment" as one year in advance of the year actually completed)—is probably of great significance in the matter of the high "mortality" in the first-year high-school class in the Philippines. About half of the students fail each year.

The fact that the normal-school graduates rank higher than the high-school graduates may be explained by the fact that, while normal-school graduates are definitely destined for the

TABLE 5.—*Showing equivalent scores in the army tests and the Otis scale.*

Letter rating.		Army test.	Otis scale.
A	Very superior intelligence	135-212	142-230
B	Superior intelligence	105-134	112-141
C+	High average intelligence	75-104	82-111
C	Average intelligence	45-74	52-81
C−	Low average intelligence	25-44	32-51
D	Inferior intelligence	15-24	22-31
D−	Very inferior intelligence	0-14	0-21

[8] Yerkes, Bridges, and Hardwick, Point Scale for Measuring Mental Ability. Baltimore (1915) 93.

[9] Yoakum and Yerkes, Army Mental Tests. New York (1920) 23.

teaching profession, most high-school graduates of high ability go into other and more remunerative employment.

Table 6 is a comparison of the results obtained with the Alpha examination in the United States Army and the Filipino teachers. It is based on the following table of equivalent scores taken from a recent circular of the World Book Company.

TABLE 6.—*Showing intelligence of American soldiers and Filipino teachers.*

Letter rating.	Meaning.	Percentage of American draft quota.[a]	Percentage of Filipino provincial teachers (men).
A	Very superior (approximate)	4-5	1.0
B	Superior	8-10	9.2
C+	High average	15-18	29.9
C	Average	25	42.9
C−	Low average	20	14.3
D	Inferior	15	2.0
D−	Very inferior		0.7

[a] The figures for the United States Army were taken from "Army Mental Tests" which has been quoted several times before.

The Filipino group contains comparatively few men of very superior intelligence, but a higher percentage of high average and average, and a lower percentage of inferior and very inferior.

The lower end of the table may be explained by the fact that the Filipino group was a selected one while the United States draft group was not. On the other hand, the smaller percentage of men of very superior ability in the Filipino group may be explained in part by the fact that many English-speaking Filipinos of ability do not enter the Government service in as much as private firms often offer more attractive salaries.

PART TWO

Table 7 shows the results obtained by applying the Otis scale to the 166 male and 59 female teachers from all parts of the Islands gathered in convention at Baguio, the summer capital of the Philippines. The more careful selection is at once apparent. The average for the men is 122.0 and for the women 115.0.

Fig. 2 gives graphically the data recorded in Table 7. Owing to the small number of individuals tested and the consequent irregularity of a curve drawn on smaller class intervals, the class interval in this case was made twenty points.

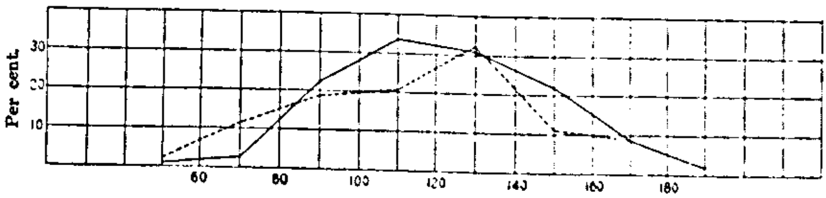

FIG. 2. Percentile distribution of scores for men and women—Baguio group.

TABLE 7.—*Showing all the scores of male and female teachers in the Baguio group.*

Score.	Number. Male.	Number. Female.	Score.	Number. Male.	Number. Female.	Score.	Number. Male.	Number. Female.
54	1		106	1		136		4
58		1	107	3		137	2	1
61	1		108	2		138	2	
62		1	109	2		139	2	2
71		1	110	3		140	1	
75	1		111	2	3	141	2	1
77		1	112	4		142	2	1
78	1	2	113	6		143	1	1
79		2	114	4	1	144	2	1
80	1		115	2	1	145	1	
82	1	1	116	5	1	146	2	1
83	1		117	2	3	147	3	
84	1		118	2		148	2	
85	1	2	119	1	2	149	1	
86		3	120	3		150	1	
88		1	121	3		152	2	
90	1	1	122	2	2	153	1	
91		1	123	3		154	2	
92	1		124	3	1	155	1	
93	4		125	6		156	1	
95	1		126	2		157	1	1
96	5	1	127	1	1	158	2	1
97	1		128	4	2	161	1	
99	2	1	129	5	1	162		1
100	1		130	1		163	1	
101	1		131	6	3	164	1	
102	6	1	132	2	2	166	2	
103	2		133	4		171	1	1
104	1		134	2		183	1	
105	2		135	1		189	1	
						Total	166	59

Table 8 gives the averages for the teachers taken in groups of educational attainment. The comparison between this table and Table 4 is very interesting. While the difference between the lowest and highest educated groups among the provincial

TABLE 8.—*Showing average scores of Baguio teachers taken in groups of educational attainment.*

[Q. C. D., Quartile coefficient of dispersion.]

Group.	Men.			Women.		
	Number.	Score.	Q.C.D.	Number.	Score.	Q.C.D.
First-year high school and normal school	46	112.1	0.10	18	95.5	0.19
Second-year high school and normal school	13	116.0	0.11	3	126.3	
Third-year high school and normal school	11	116.1	0.19	7	115.0	0.22
Fourth-year and graduate normal school	47	128.2	0.13	22	125.9	0.09
Fourth-year and graduate high school	16	129.7	0.08	4	106.7	0.07
College graduates and undergraduates	33	129.9	0.13	5	136.8	0.04
Total	166			59		

teachers amounted to more than 50 points, this difference in the Baguio group amounts to but some 17 points (men only). First-year high- and normal-school men in the provincial group scored 73.5, while the same group among the Baguio teachers scored 112.1. The teachers who convene annually at Baguio are among the best teachers in the service. They are carefully selected by their respective division superintendents and sent to Baguio at Government expense to take part in various conferences and to learn of new ideas and methods in education. Tables 4 and 8 would seem to prove that schooling has but a slight influence, even among Filipinos, on the scores obtained in tests of native mental ability.

TABLE 9.—*Showing average scores of various racial types—Baguio group.*

Type.	Men.			Women.		
	Number.	Range.	Average score.	Number.	Range.	Average score.
Malay	52	54-183	121	32	62-158	116
Spanish-mestizo	19	111-152	124	4	128-157	140
Indonesian	40	84-161	125			
Proto-Malay	10	85-166	127			
Chinese-mestizo	19	97-189	132	7	88-171	129

The Baguio group was too small and too carefully selected to bring to light facts of general applicability. However, each individual was classified as to his physical or racial type. Many of the individuals were much mixed, racially, and the classification, therefore, was far from satisfactory. But the average scores of the various racial types are given in Table 9, not so much to indicate the relative intelligence of these Philippine

racial types, but to show that each type contains individuals of high mental ability. The table is given for what it is worth.

Direct comparison between the scores obtained in the Otis scale by Americans and Filipinos would hardly be fair, owing to the different conditions; but, for the sake of completeness, the following American norms are given:

Year.	Score.
8	40
9	52
10	64
11	76
12	88
13	100
14	112
15	121
16	125
17	128
18	130

In a letter to me Doctor Otis says:

> The normal intelligence for adults is considered to be constant for all ages above 18 years and is represented by a score of 130 points. Teachers are considered to be a group above "average" in intelligence and will range from 100 to 200 points in their scores.

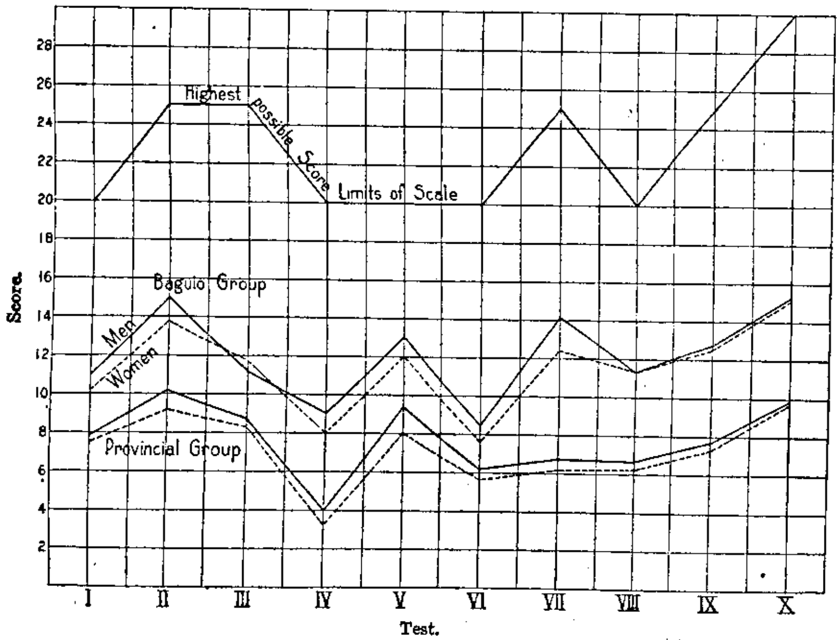

FIG. 8. Average scores in each test separately.

Fig. 3 is a profile graph showing the average performance of both groups in each individual test, for both males and females. It will be seen that both groups scored comparatively low in test 4, which is a test in the interpretation of proverbs. The language element, however, and English idiomatic expression is too considerable an element in this test to make it a fair one for Filipinos. In spite of this fact the results obtained with this test bear a high correlation with the general intelligence score. The same is true of test 7, completing analogies. The results obtained with test 3, arranging disarranged sentences, and with test 6, discriminating between geometric figures, show a lesser correlation with the general intelligence score.

In regard to the relation between the scores of the men and those of the women it appears that the same is true in the Philippines as elsewhere. It will be seen that the difference is least in the tests which involve memory to any large extent. Yerkes and Burtt concluded—

> College men with respect to the majority of the intellectual functions measured by the point scale method, rank higher than college women * * * This superiority of the men is especially marked in tests which involve reasoning and other fairly complex thought processes.[10]

PART THREE

Part three of this paper gives the results of the application of the Yerkes point scale[11] to a number of school children in the Provincial Intermediate and High School at Cuyo, Palawan.

The point scale consists of twenty separate tests, each of which involves the mental functions enumerated in Table 10.

The point scale was slightly adapted as follows:

Test 9: "Orange" substituted for "apple," for the apple is not a tropical fruit; "iron" substituted for "glass," for glass is not common in Cuyo. Test 14: "Cuyo" substituted for "Boston," and "ocean" for "river," for Cuyo cannot boast of a river. Test 15: "Missing the boat" substituted for "missing the train," for few Cuyono children had ever seen anything but the picture of a train. Test 20: "Foot is to shoe" substituted for "hand is to glove," for gloves are about as common in Cuyo as fans in the Arctic region.

Cuyo is a small island, some 8 by 11 kilometers, in the Sulu

[10] Yerkes and Burtt, The Relation of Point-Scale Measurements of Intelligence to Educational Performance in College Students, School and Society (May 5, 1917).

[11] Yerkes, Bridges, and Hardwick, A Point Scale for Measuring Mental Ability. Baltimore (1915).

TABLE 10.—*The point scale tests.*

Test.	Principal mental functions.	
1	Æsthetic judgment	Perception, association, analysis.
2	Perception	Apperception, visual memory, imagination.
3	Discrimination	(a) Visual, (b) kinæsthetic.
4	Auditory memory	For words, attention.
5	Memory	Imagination, attention.
6	Auditory memory	For sentences, attention.
7	Perception (visual)	Of things, relations, meanings.
8	Kinæsthetic discrimination	Ideation (notion of series) attention.
9	Analysis and comparison	Of remembered objects, attention.
10	Ideation	Association, analysis.
11	Suggestibility	Visual perception, comparison.
12	Motor coördination	Visual perception.
13	Association (free)	Vocabulary, attention.
14	Imagination and command of language forms.	
15	Practical judgment	Memory, imagination.
16	Visual memory	Perception, attention, motor coördination.
17	Logical judgment	Imagination, analysis, reasoning.
18	Ideation	Analysis, imagination, command of language forms.
19	......do	Vocabulary, memory, analysis.
20	Logical judgment	Analysis, reasoning, attention, memory.

Sea, between the larger islands of Panay and Palawan. The people of Cuyo are Christians, and their culture is the general Spanish-Filipino culture of the Bisayan type. Physically they belong to the Malay blend type, but with the Indonesian B element very prominent.[12] In Cuyo itself there has been some intermarriage with Spaniards. Due to the island's small size and its isolation most of the young men leave it to seek opportunity elsewhere. This has left the number of women far in excess of the men.

The Agutaynos are a people who live on a still smaller island, Agutaya, about 48 kilometers north of Cuyo. Their speech differs considerably from that of the Cuyonos.

Beyer, of the University of the Philippines, says that there is considerable evidence that the Cuyonos and Agutaynos are Christianized Tagbanuas, a pagan group now dwelling in the mountainous interior of Palawan.[12]

In both islands the people are inbred to a considerable extent. Most of the people in Cuyo belong to one of two large families, and nearly everyone is some sort of relative of everybody else.

The data obtained in Cuyo are almost too meager to warrant a special paper, but as I do not expect to visit Cuyo again, I am

[12] Beyer, H. O., Population of the P. I. in 1916 (1917) 49, 73. Also his paper on the Non-Christians in the Census of the P. I. for 1918 2 (1921) 907–957.

forced to make the best of the little I was able to gather during the year of my residence there—1917–1918.

Table 11 shows the classes and numbers of children examined. All of these children were pupils in the fifth, sixth, and seventh grades of the intermediate school or first- or second-year pupils in the high school.

TABLE 11.—*Showing the classes and numbers of children examined in Cuyo.*

Classification.	Boys.	Girls.
Cuyonos	52	12
Agutaynos	17	
Cuyono-Agutaynos	8	1
Spanish-Cuyonos	29	7
Tagalog-Cuyonos	9	1
Chinese-Cuyonos	4	1
American-Cuyonos	3	2
Unclassified	24	6
Total	146	30

TABLE 12.—*Showing the scores of all the boys and girls and their frequencies.*

BOYS.

Age.	No.	Scores and frequencies.	Average.
11	1	60	60
12	5	51, 54, 59, 66, 78	62
13	12	43, 48, 49, 53, 54(2), 58, 62, 64, 65, 70, 81	58
14	8	53, 54, 55, 56, 57, 62, 64, 81	60
15	19	42, 48, 49(2), 53(3), 55, 57, 58, 63, 67, 69, 71, 73, 74, 75(2), 83	61
16	18	48, 54(2), 57(2), 59, 61, 64, 70, 73, 76, 82, 84(2), 86, 87(2), 88	71
17	19	53, 55, 56(2), 60, 61, 66(3), 68, 70, 73(2), 74(2), 77, 78, 84, 85	68
18	28	48, 49, 52, 53(2), 60, 62, 63(2), 67, 71(3), 73, 76, 77, 78, 79(2), 81, 83, 84, 85, 87, 88, 89, 91, 95	72
19	20	52, 57(2), 58, 61, 62(3), 65, 69, 72, 73, 74, 75(2), 79, 81, 83(2), 89	69
20	8	53, 65, 67, 72, 74, 76, 87, 88	73
21	1	61	61
22	2	68, 78	73
23	3	69, 73, 79	74
27	1	67	67
		GIRLS.	
10	1	59	59
11	3	41, 60, 62	54
12	1	66	66
13	5	55, 65, 66, 74(2)	67
14	8	46, 55, 56, 58, 59, 63, 71, 80	61
15	9	46, 47, 56, 60, 71, 72, 75, 78, 85	66
16	1	77	77
18	1	71	71

Table 12 shows the scores of all the boys and girls, and their frequencies. Table 13 gives the scores of the boys and girls by school grade. Figs. 4 and 5 show the same data graphically. The grade curve (fig. 5) is fairly regular, indicating that the grading in the school showed a close correlation with intelligence. This is as it should be. The age curve (fig. 4) is not so regular. The poor performance of the older pupils is due, of course, to

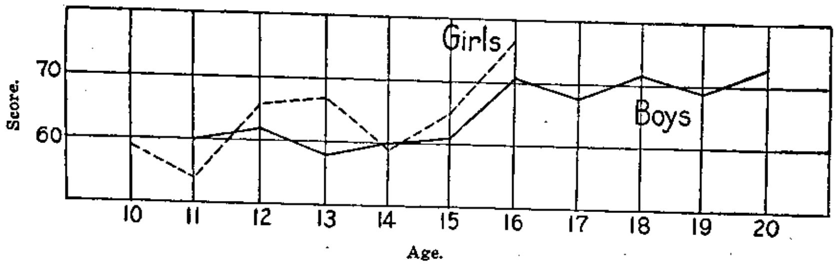

FIG. 4. Average scores of all the boys and girls from 10 to 20 years of age.

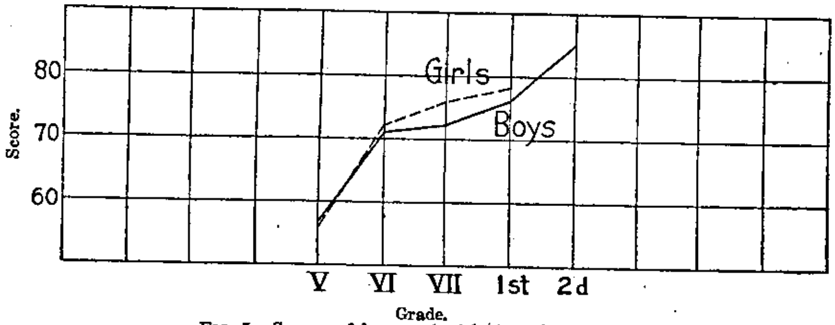

FIG. 5. Scores of boys and girls by school grade.

the fact that they were repeaters in their grades with all that that means. It will be seen that the girls, at least between the ages of 12 and 16, did better than the boys. Somewhat similar results have been brought out in America.[13]

Table 14 gives the averages at different ages for the pure Cuyonos and Agutaynos and for the various mestizo groups. Fig. 6 shows the difference between the scores of the Cuyonos and Agutaynos, the latter ranking much lower. Fig. 7 is a comparison of the scores of the Spanish- and Tagalog-Cuyono mesti-

[13] Yerkes, Bridges, and Hardwick, A Point Scale for Measuring Mental Ability. Baltimore (1915) 69 f.; Stern, Psychological Methods of Testing Intelligence. Baltimore (1914) 65 f.; Terman, The Measurement of Intelligence. New York (1916) 68 f.

zos with those of the pure Cuyonos. The mestizos are seen to be superior. Fig. 8 shows the superiority of the combined mestizo groups over the pure Cuyono group by ages. The results are rather striking; but the insufficiency of the data does not allow of many generalizations. It may be said, however, with little chance of error that the inbred Cuyono strain is enriched by intermixture with outside blood.

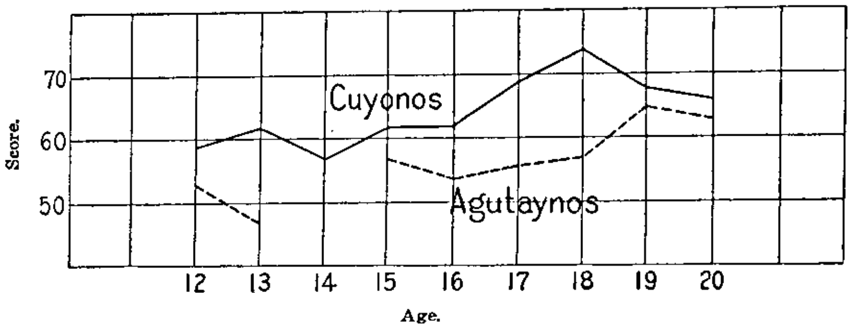

FIG. 6. The difference between the scores of Cuyonos and Agutaynos.

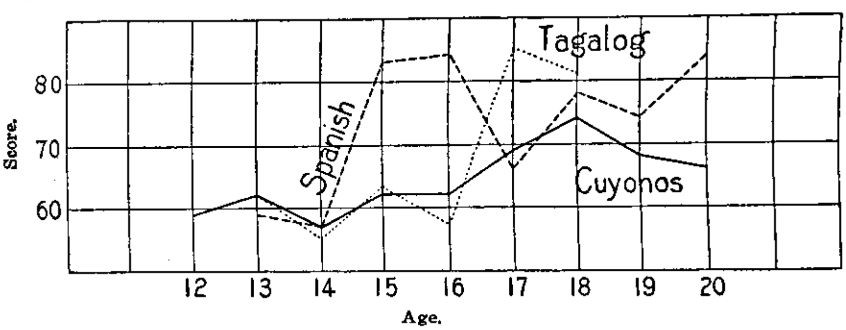

FIG. 7. Comparison of the scores of Spanish-Cuyono and Tagalog-Cuyono mestizos with the scores of pure Cuyonos.

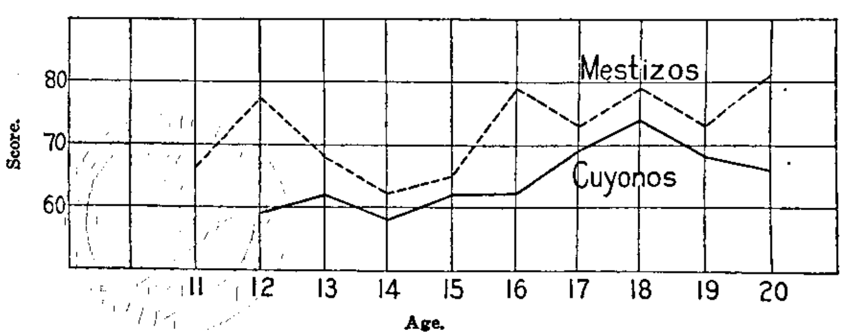

FIG. 8. Showing the superiority of the combined mestizo groups over the pure Cuyono group.

TABLE 13.—*Showing scores of boys and girls by school grade.*

BOYS.

Grade.	Number.	Scores and frequencies.	Score Average.	Age. Range.	Age. Average.
V	65	42, 43, 48(4), 49(4), 51, 52(2), 53(8), 54(6), 55(3), 56(2), 55(3), 56(2), 57(5), 58(3), 59(2), 60(2), 61(3), 62(3), 63(2), 64(3), 65(2), 66, 67(2), 68, 70(2), 78, 81	57	11-21	15
VI	6	56, 71(2), 72, 74, 81	71	13-19	16
VII	37	53, 57, 60, 62(2), 65, 66(2), 67(2), 68, 69(3), 71(2), 72, 73(4), 74, 75(3), 76(2), 77, 78, 79, 81, 83, 84, 85, 87, 88	72	15-23(27)	18(22)
I H. S.	24	62, 63, 66(2), 70, 73(3), 74(3), 75, 76, 77, 78, 79(2), 82, 83(2), 84, 85, 87, 88	76	15-23(27)	18(19)
II H. S.	14	78, 79, 81, 83, 84(2), 86, 87(2), 88, 89(2), 91, 95	85	16-20	18

GIRLS.

Grade.	Number.	Scores and frequencies.	Score Average.	Age. Range.	Age. Average.
V	17	41, 46(2), 47, 55(2), 56(2), 58, 59(2), 60, 62, 63, 65, 66(2)	56	10-15	13
VI	7	60, 71(2), 74(2), 77, 78	72	14-18	15
VII	3	71, 72, 85	76	15	15
I H. S.	2	75, 80	78	14-15	15

TABLE 14.—*Showing the averages at different ages for the pure Cuyonos and Agutaynos and for the various mestizo groups.*

Type and sex.	Age	Scores and frequencies.	Average.
Cuyono boys	12	59	59
Do	13	54, 58, 64, 70	62
Do	14	54, 56, 62	57
Do	15	49, 49, 53, 55, 58, 67, 74, 75, 75	62
Do	16	48, 54, 57, 59, 61, 64, 73, 82	62
Do	17	61, 66, 68, 70, 73, 74, 74	69
Do	18	49, 62, 63, 71, 76, 77, 79, 81, 83, 84, 89	74
Do	19	57, 61, 62, 65, 69, 73, 75, 81	68
Do	20	65, 67	66
Do	21	61	61
Cuyono girls	10	59	59
Do	13	55, 65, 74	65
Do	14	55, 56, 58, 59, 63	58
Do	15	47, 71	71
Do	18	71	71
Agutayno boys	11	60	60
Do	12	51, 54	53
Do	13	43, 48, 49	47
Do	15	48, 53, 71	57
Do	16	54	54
Do	17	53, 55, 56, 56, 60	56

TABLE 14.—*Showing the averages at different ages for the pure Cuyonos and Agutaynos and for the various mestizo groups*—Continued.

Type and sex.	Age.	Score and frequencies.	Average.
Agutayno boys	18	48, 52, 53, 53, 63, 71	57
Do	19	58, 72	65
Do	20	53, 72	63
Do	22	68	68
Do	23	73, 79	76
Agutayno girls	11	41	41
Do	14	71	71
Do	15	56, 75	66
Spanish-mestizo boys	11	66	66
Do	13	53, 65	59
Do	14	57	57
Do	15	83	83
Do	16	76, 84, 87, 87	84
Do	17	66	66
Do	18	60, 67, 73, 78, 79, 85, 87, 95	78
Do	19	57, 58, 74, 75, 79, 83, 89	74
Do	20	76, 87, 88	84
Spanish-mestiza girls	11	60, 62	61
Do	12	66	66
Do	13	66, 74	70
Do	15	72, 78	75
Cuyono-Agutayno mestizo boys	14	53	53
Do	15	42, 63, 73	59
Do	17	66, 73, 77	72
Do	22	78	78
Cuyono-Agutayno mestiza girls	15	60	60
American-Cuyono mestizo boys	12	78	78
Do	13	81	81
Do	14	81	81
American-Cuyono mestiza girls	15	85	85
Do	16	77	77
Chinese-Cuyono mestizo boys	16	70, 78, 88	79
Do	19	62, 83	73
Chinese-Cuyono mestiza girls	14	80	80
Tagalog-Cuyono mestizo boys	13	62	62
Do	14	55	55
Do	15	57, 69	63
Do	16	57	57
Do	17	85	85
Do	18	71, 91	81
Do	20	74	74
Tagalog-Cuyono mestiza girls	14	46	46

Table 15 shows the performance of the pure Cuyonos and the combined mestizo groups in each separate test. The table is not exact, for the averages are based on mere inspection, but it will serve to bring out the general facts.

For the sake of completeness the following norms for children of non-English-speaking parents in America are given. How-

ever, the Cuyono pupils were at a social and lingual disadvantage even to these.[14]

TABLE 15.—*Performance of pure Cuyonos and combined mestizo groups in each test.*

Test.	Maximum credits.	Cuyonos.	Mestizos.
1	3	3	3
2	4	4	4
3	3	3	3
4	5	3	4
5	4	4	4
6	6	2	3
7	9	6	7
8	2	2	2
9	6	6	6
10	8	6	7
11	3	2	2
12	4	4	4
13	4	2	3
14	4	3	4
15	8	2	4
16	4	3	3
17	5	2	3
18	6	3	5
19	6	1	2
20	6	2	3
Total	100	63	76

TABLE 16.—*Point-scale norms for children of non-English-speaking parents in America.*

Age.	Scores.	
	Boys.	Girls.
Years.		
9	46	51
10	58	55
11	61	65
12	66	68
13	66	75
14	74	76
15	69	76

[14] Yerkes, Bridges, and Hardwick, A Point Scale for Measuring Mental Ability. Baltimore (1915) 72.

ILLUSTRATIONS

TEXT FIGURES

PRESSURES REQUIRED TO CAUSE STOMATAL INFECTIONS WITH THE CITRUS-CANKER ORGANISM

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and

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TWO TEXT FIGURES

In the study of citrus canker, there have been found several species of *Citrus* with more or less resistance to the disease. Notable among such resistant species are the mandarin orange varieties which in the orchards of heaviest infection in Japan, China, and the Philippines remain almost entirely free from the disease. In connection with this disease resistance, interest is naturally stimulated to investigate the characters of the disease-free varieties which determine their resistance. With fungus diseases on various hosts, it has been shown in many instances that leaf-attacking fungi send mycelial threads from their spores, through the stomata. Leaf-attacking bacteria, such as the citrus-canker organism, which are motile in water, possibly can enter through the stomata, if the stomatal pores are filled with water. It seems scarcely probable that they would be carried through the stomata in the dry state, under usual circumstances.

The authors [1] have shown in previous papers that the resistance to canker of the mandarin orange is due to some character of the epidermis of that species. It was further shown by the senior writer [2] that the stomata of the mandarin orange, the resistant form, differed markedly from the structure of such a very susceptible species as the grapefruit. These differences

[1] McLean, Forman T., and Lee, H. Atherton, The resistance to citrus canker of Citrus nobilis and a suggestion as to the production of resistant varieties in other species, Phytopath. 11 (1921) 109–114a.

[2] McLean, Forman T., A study of the structure of the stomata of two species of Citrus in relation to citrus canker, Bull. Torrey Bot. Club 48 (1921) 101–106.

have further been shown to cause the leaves of grapefruit to be more permeable to water than are those of the more canker-resistant mandarin orange.[3] It was also demonstrated in another paper that water could be forced through the uninjured stomata of grapefruit by the application of comparatively little pressure.

The above-mentioned studies strongly suggested that the differences in structure of the stomata and permeability of the leaves of mandarin and grapefruit are responsible for the resistance to canker of the former and the susceptibility of the latter. At this stage of the investigations it seemed desirable to attempt by some means to introduce the canker bacteria within the leaf tissue of the resistant mandarin orange variety without mechanical injury; if canker resulted it would be apparent that the tissues were not dependent on injury to render them susceptible. Moreover, the development of canker lesions on this host, after withdrawing the air from the stomata, would substantiate the theory that it is the peculiar structure of the stomata in the leaves of the mandarin orange that contributes to resistance.

In the study here reported, a method has been devised for drawing water into intact leaves on the tree in the orchard, by the use of known and easily measurable pressure. Canker has been produced in young leaves of the mandarin orange, grapefruit, and pummelo by substituting an infusion of *Pseudomonas citri* Hasse for the water. The experiments are described in the following paragraphs.

APPARATUS AND PROCEDURE

The device used to force water and canker organisms into the citrus leaves was an adaptation of the porometer.[4] It consisted of a suction tube with a rubber lip for pressing against the leaf, a mercury pressure gauge connected with it to indicate the reduced pressure in the suction tube, and a simple aspirator, also connected with the suction system, the rate of withdrawal

[3] McLean, Forman T., The permeability of Citrus leaves to water, Philip. Journ. Sci. 19 (1921) 115–123.

[4] Darwin, F., and Pertz, D. F. M., A new method of estimating the aperture of stomata, Proc. Roy. Soc. London, Ser. B, No. B569 (1911) 136–154; Trelease, Sam F., and Livingston, B. E., The daily march of transpiring power as indicated by the porometer and by standardized hygrometric paper, Journ. Ecol. No. 1 4 (March 1916) 1, abs. in Science New Ser. 43 (1916) 363.

of air from the suction system into the aspirator being controlled by a screw pinchcock (see fig. 1). The operation of the apparatus was very simple. Mercury was sucked up into the aspirator tube, with the screw pinchcock closed. The suction tube was then closed at the bottom by a pinchcock, and the screw cock

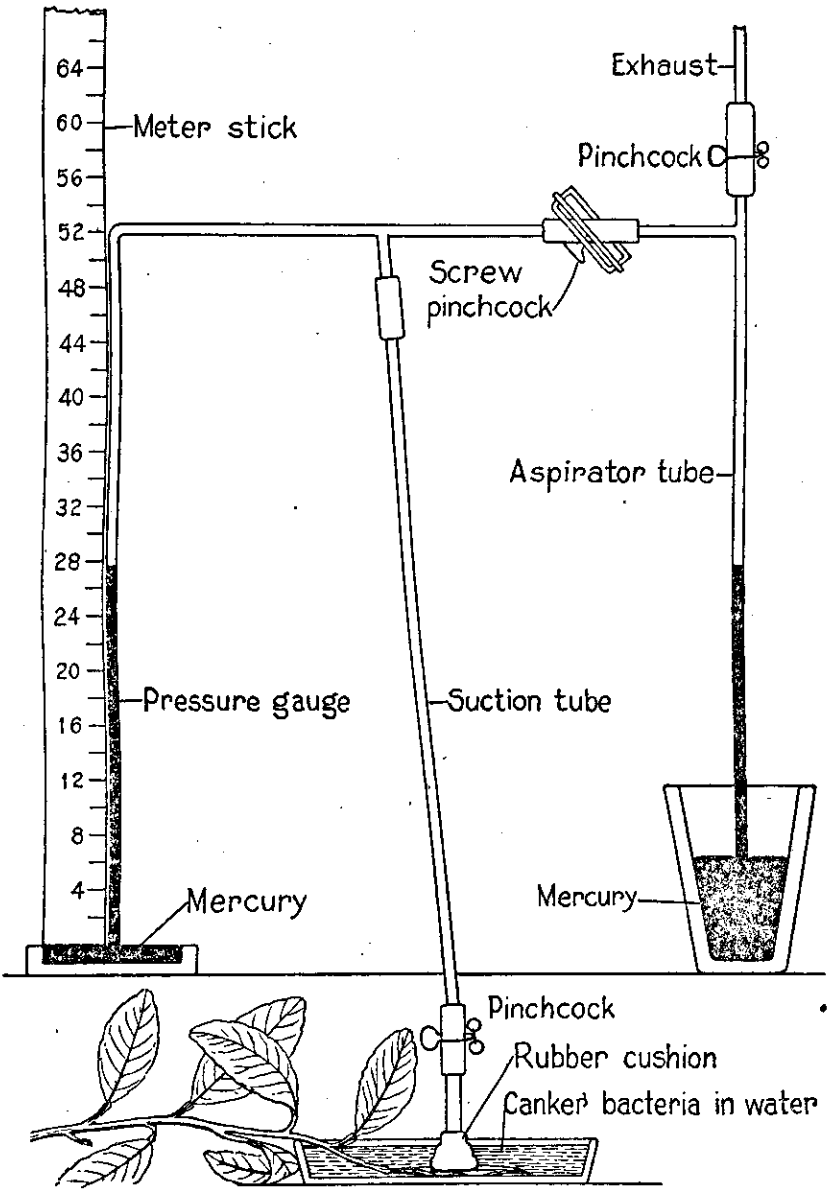

FIG. 1. Apparatus used to inject leaves with citrus-canker organisms.

cautiously opened, allowing the air to be withdrawn from the suction system until the desired reduction in atmospheric pressure was indicated in the pressure gauge. The suction tube was then applied to the under surface of a citrus leaf, which was immediately submerged in an infusion of the citrus-canker bacteria. The pinchcock was then opened and suction thus applied to the leaf surface. This caused withdrawal of air from the leaf through the stomata in the same manner as with a porometer, except that in this case, the leaf being submerged, air could not enter, and thus the pressure of the air inside the leaf was ultimately reduced to the same amount as in the suction tube.

It was found that, by reducing the pressure in the apparatus and leaf sufficiently, the infusion would be drawn into the leaf tissues by atmospheric pressure and hydrostatic pressure combined. The hydrostatic pressure was of course low as compared to the differences in pressure between the atmosphere and the apparatus, since the dish in which the leaves were submerged was filled with liquid to a depth of about 3 centimeters only. The presence of water in the intercellular spaces of the leaf could only be detected when these were flooded. For this reason it is quite probable that small amounts of water might, under pressure, enter the leaves through the stomata without being detected. Injection was only recorded when the intercellular spaces of the leaf were evidently flooded in spots. This visible injection in most cases occurred at a considerable distance from the suction tube (the injector), thus clearly demonstrating that the reduced pressure caused by the suction tube extended throughout the internal air spaces of the leaf.

The injection usually appeared at first as a single translucent spot on the leaf, which gradually spread and was generally followed by the appearance of several other spots at different points. If the pressure inside the leaf was not still further reduced after injection was first observed, these spots did not spread rapidly nor involve a very large part of the leaf. Frequently the spread of the spots stopped after they had attained a diameter of 1 or 2 millimeters. From these facts it was deemed probable that still smaller amounts of water might, in some cases, have been drawn into the leaf with less extreme pressure without being detected.

INJECTION TESTS

In April and May, 1921, during the dry season, a number of tests were made of the pressure required to inject water into

citrus leaves, using the apparatus described above.[5] The results of these determinations showed clearly that the permeability varies greatly for leaves of the same age and on the same tree, so that large numbers of readings are necessary to establish satisfactory averages.

The Szinkom mandarin orange variety employed in the experiments is a variety successfully grown in the Philippines; although introduced here from India, it is believed to be a native of China. It is one of the most canker-resistant horticultural varieties of any of the citrus species. The grapefruit trees employed in the experiment were in a few cases of the Pernambuco variety, and in others of a seedling variety, all rather susceptible, according to field observations. Since grapefruit leaves were not sufficiently abundant, a susceptible pummelo variety was chosen to complete the comparative tests. The pummelo trees were of the East Indian type, also known as shaddocks; they also were matured seedlings. In the field, from the amounts of natural infection, one would judge these trees employed in the experiments to have much the same degree of susceptibility as the grapefruits. The results with four *Citrus* varieties are summarized in Table 1.

TABLE 1.—*Results of application of pressure on leaves of Citrus species immersed in water.*

Variety.	Tests.	Pressures causing injection.		
		Average.	Highest.	Lowest.
		cm.	*cm.*	*cm.*
Pernambuco grapefruit	60	19.5	53.0	10.0
East Indian pummelo	130	19.6	55.0	5.5
Washington navel orange	75	20.8	50.5	9.0
Szinkom mandarin orange	18	33.6	55.0	11.8

The range of values from the highest to the lowest seems to be about the same for all varieties tested. The highest value, 55 centimeters, represents the highest mercury column attainable with the apparatus, and a number of leaves failed to be injected even with this extreme pressure. The average values appear to be more significant, the more-susceptible grapefruit and pummelo being the easiest to inject and the highly resistant Szinkom mandarin orange the most difficult, the Washington

[5] Most of these tests were made by S. Bacol, R. Cuitiong, M. Punzalan, F. Esguerra, F. Rodis, and T. Bautista, all advanced students in plant nutrition, working under the direction of the senior author.

navel orange being intermediate both in injection pressure and canker resistance. The comparisons of the average injection pressures thus apparently indicate that injection pressure is an approximate index of resistance to citrus canker. The work was then repeated, substituting an infusion of *Pseudomonas citri* for the water-bath immersion.

INJECTION TESTS WITH INFUSION OF PSEUDOMONAS CITRI

In the following experiments young, actively growing leaves were used of such condition as to be judged readily susceptible to infection with *Pseudomonas citri.*. The leaves were in all cases on mature orchard trees, growing under identical environmental conditions.

The infusion used was made from cultures of *Pseudomonas citri* on potato plugs. The cultures used were of the same age, and in comparative tests the same infusion was used. The temperature of the infusion during the experiment varied between 28° and 31° C.

In a few cases, cankers developed at the point of contact of the injector with the leaf. These cankers were recorded as at wounds. The cankers not so noted were on apparently uninjured parts of the leaves and at a distance from the point of injector contact.

The experimental results are presented in Tables 2, 3, and 4.

TABLE 2.—*Showing the results of immersing leaves of the Szinkom mandarin orange in an infusion of Pseudomonas citri and exerting graduated degrees of pressure upon such leaves.*

Pressure of mercury column.	Twig No.	No. of leaf from tip of twig.	Condition of leaves.	Incubation period.	Cankers.
cm.				*Days.*	
0.0	4	8	Full grown	11	None.
0.0	4	9	do	11	Do.
0.0	4	10	do	11	Do.
0.0	6	3	do	11	Do.
0.0	8	1	Half grown	11	Do.
0.0	8	2	Two-thirds grown	11	Do.
0.0	8	3	do	11	1[a]
0.0	11	1	One-fourth grown	26	1
0.0	11	2	Half grown	26	1
0.0	11	3	do	26	4
2.4	3	3	do	11	1
2.5	1	1	Two-thirds grown	11	None.
2.6	7	1	Full grown	11	Do.
2.8	9	4	Two-thirds grown	26	5[b]

[a] Infection at evident wound. [b] Character of infection suggests wounds.

TABLE 2.—*Showing the results of immersing leaves of the Szinkom mandarin orange in an infusion of Pseudomonas citri and exerting graduated degrees of pressure upon such leaves*—Continued.

Pressure of mercury column.	Twig No.	No. of leaf from tip of twig.	Condition of leaves.	Incubation period.	Cankers.
cm.				*Days.*	
3.7	6	1	Half grown	11	None.
4.0	3	2	....do	11	Do.
5.0	1	2	Two-thirds grown	11	Do.
5.0	4	7	Full grown	11	Do.
5.0	7	4	Three-fourths grown	11	Do.
5.1	9	3	....do	26	Do.
5.5	3	1	Half grown	11	Do.
5.6	6	2	Full grown	11	Do.
7.3	3	5	Half grown	11	Do.
7.5	7	3	Two-thirds grown	11	Do.
8.0	4	1	One-third grown	11	Do.
9.5	7	2	Half grown	11	3[a]
10.0	1	3	Two-thirds grown	11	None.
10.0	3	4	Half grown	11	2
10.2	9	2	Two-thirds grown	26	
10.5	5	4	Full grown	11	None.
10.5	4	6	....do	11	6
11.4	10	1	Half grown	26	5
12.0	7	1	....do	11	None.
12.2	10	2	Three-fourths grown	26	1
12.4	8	8	Full grown	11	None.
13.4	9	1	Half grown	26	Numerous.[c]
14.0	10	3	Three-fourths grown	26	1[b]
14.4	3	7	....do	11	None.
14.4	4	5	Two-thirds grown	11	Do.
[a]15.5	5	3	Full grown	11	1
16.0	1	4	Three-fourths grown	11	None.
[d]16.2	5	5	Full grown	11	Do.
18.0	4	2	One-third grown	11	4[a]
[d]19.0	3	6	Three-fourths grown	11	Numerous.
[d]19.9	10	4	Full grown	26	Do.
20.2	2	2	One-third grown	11	
[d]20.5	5	2	Three-fourths grown	11	Numerous.
[d]21.0	4	4	Half grown	11	10
21.0	2	1	Two-thirds grown	11	
[d]21.5	9	6	Full grown	26	Numerous.
[d]21.8	9	5	....do	26	4
[d]26.7	5	1	Two-thirds grown	11	Numerous.
[d]42.0	4	3	Half grown	11	Do.

[a] Infection at evident wound.
[b] Character of infection suggests wounds.
[c] Numerous; this observation was recorded only when the cankers were present so abundantly as to make an accurate count impossible.
[d] Leaf injected with infusion at the pressures recorded.

To summarize briefly the results recorded in Table 2, with a very few exceptions immersion of Szinkom mandarin orange

leaves, with low pressures exerted, resulted in no infection. Up to the pressures registered with the mercury column at 10 centimeters the results were largely negative. The few exceptions to this are easily understandable from the notes from the field notebook, appended below the table; nevertheless, the results from twig 11 do not seem possible of explanation from the recorded data. It only seems possible that the twig was abnormal, or that some slight insect attack resulted shortly after immersion of the leaves. With the exception of this one twig the results are completely consistent. Even above the pressures of 10 centimeters there was no general infection until pressures

TABLE 3.—*Showing the results of immersing leaves of a grapefruit seedling tree in an infusion of Pseudomonas citri and exerting graduated degrees of pressure upon such leaves.*

Pressure.	Twig No.	No. of leaf from tip of twig.	Condition of leaves.	Incubation period.	Cankers.
cm.				*Days.*	
0.0	1	1	One-third grown	10	None.
0.0	1	7	Full grown	10	2[a]
0.0	1	8	do	10	None.
0.0	2	1	One-third grown	10	Numerous.[b]
0.0	2	2	do	10	Do.
0.0	2	10	Full grown	10	None.
0.0	2	11	do	10	2
0.0	3	4	Three-fourths grown[c]	27	Numerous.
2.0	2	9	Full grown	10	2
2.5	1	2	Half grown	10	None.
4.5	2	8	Full grown	10	2
5.0	3	7	do	27	Numerous.
5.3	1	3	Half grown	10	1
6.5	1	4	Two-thirds grown	10	None.
7.7	3	6	Full grown	27	Numerous.
8.0	2	7	do	10	None.
[d]8.2	1	5	Three-fourths grown	10	Do.
10.0	2	6	do	10	Numerous.
10.1	3	5	Full grown	27	Do.
10.4	3	1	Half grown	27	3
12.5	2	5	Three-fourths grown	10	3
[d]13.0	1	6	Full grown	10	1
[d]14.3	3	2	Half grown	27	Numerous.
14.4	3	3	do	27	Do.
15.0	2	4	do	10	Do.
[d]18.0	2	3	One-third grown	10	Do.
[d]28.0	3	8	Full grown	27	Do.

[a] At wounds.

[b] Numerous; this observation was recorded only when an accurate count of the cankers was impossible because of their number.

[c] Leaf-miner injuries present.

[d] Injected.

with the mercury at 19 and 20 centimeters and above were reached.

For comparison with these results Tables 3 and 4 of grapefruit and pummelo tests are given.

TABLE. 4.—*Showing the results of immersing leaves of a pummelo seedling tree in an infusion of Pseudomonas citri and exerting graduated degrees of pressure upon such leaves. Incubation period twenty-seven days.*

Pressure.	Twig No.	No. of leaf from tip of twig.	Condition of leaves.	Cankers.
cm.				
0.0	1	5	Two-thirds grown	Numerous.
0.0	2	1	One-fourth grown	None.
0.0	3	4	Two-thirds grown	Numerous.
0.0	4	6	Full grown	Several.
0.0	5	4	Three-fourths grown	Numerous.
3.1	2	5	Half grown	Do.
4.7	2	2	do	Do.
5.0	3	1	One-third grown	Do.
5.2	4	5	Full grown	Do.
7.3	2	3	Half grown	Do.
7.6	4	4	Three-fourths grown	Do.
7.8	3	2	Half grown	Do.
8.8	5	6	Full grown	Do.
9.6	3	3	Half grown	Leaf fallen.
9.6	1	4	Two-thirds grown	Numerous.
10.0	4	2	Half grown	Do.
10.0	5	5	Three-fourths grown	Do.
10.2	4	3	Two-thirds grown	7
10.9	5	3	do	Numerous.
[a]11.2	1	2	do	Do.
[a]11.9	5	2	do	Do.
[a]12.3	4	1	Half grown	Do.
[a]13.0	5	1	Two-thirds grown	Do.
13.3	3	5	do	Leaf fallen.
17.0	1	1	Half grown	Numerous.
35.0	1	3	Two-thirds grown	Do.

[a] Injected.

Whereas in the Szinkom mandarin orange infection of leaves took place mainly at pressures recorded by 10 centimeters of mercury and higher, in the tests of grapefruit leaves shown in Table 3 infection took place readily, either without pressure or at very low pressures. Five of the seven negative results with grapefruit were on twig 1, which was on a separate tree and was apparently more resistant than the others. Although the results are not so consistent as in Table 1, it is very evident that abundant infection took place at much lower pressures

than in the case of the Szinkom mandarin orange. Infections were numerous at pressures indicated by 10, 7, and 5 centimeters of mercury, and even with only the almost negligible hydrostatic pressure of the liquid in which the leaves were submerged.

In Table 4 results on pummelos are recorded.

The results of the tests recorded in Table 4 are uniformly positive, with the single exception of leaf 1, twig 2. It is evident that at very low mercury pressures, and even with simple immersion, the citrus-canker organism gains ready access to the tissues of the leaves of this host.

The observed injection pressures shown in Tables 1, 2, 3, and 4 are much higher than the pressures which cause canker infection, thus indicating that water and canker organisms are drawn into the leaf tissues at lower pressures than those causing visible injection. The pressure causing visible injection thus appears to be roughly proportionate to that necessary for infection, but not identical with it.

DISCUSSION OF RESULTS

It is apparent from the foregoing results that canker will develop in the leaves of the mandarin orange, even in the absence of injury to the tissues, once the canker bacteria have gained entrance into the leaf.

It has been concluded from the results presented in the papers previously listed, that the resistance to citrus canker of the mandarin orange varieties is due to mechanical peculiarities of structure, and that such mechanical peculiarities apparently exist in the epidermis. It was also shown that the character of the stomata of the mandarin orange was such as to prevent the ready ingress of water; the results just presented, moreover, show that in the mandarin orange pressure is required to draw the water into the stomata. On the other hand, it has been shown that the stomata in the grapefruit are of such a structure as to fill readily with water, and the foregoing experiments indicate that simple immersion is sufficient to fill the stomata with water and cause stomatal infections.

The present results, therefore, rather definitely support the theory previously advanced that the resistance of the mandarin orange is dependent upon its stomatal structure and that the structural differences in the stomata of the mandarin orange and grapefruit and pummelo constitute at least one cause for their differences in susceptibility to citrus canker. The struc-

ture of the stomata of the mandarin orange is such as to exclude water, thus preventing the ingress of the canker bacteria. The structure of the stomata of the grapefruit is such as readily to allow the ingress of water on the surface of the leaf, thus

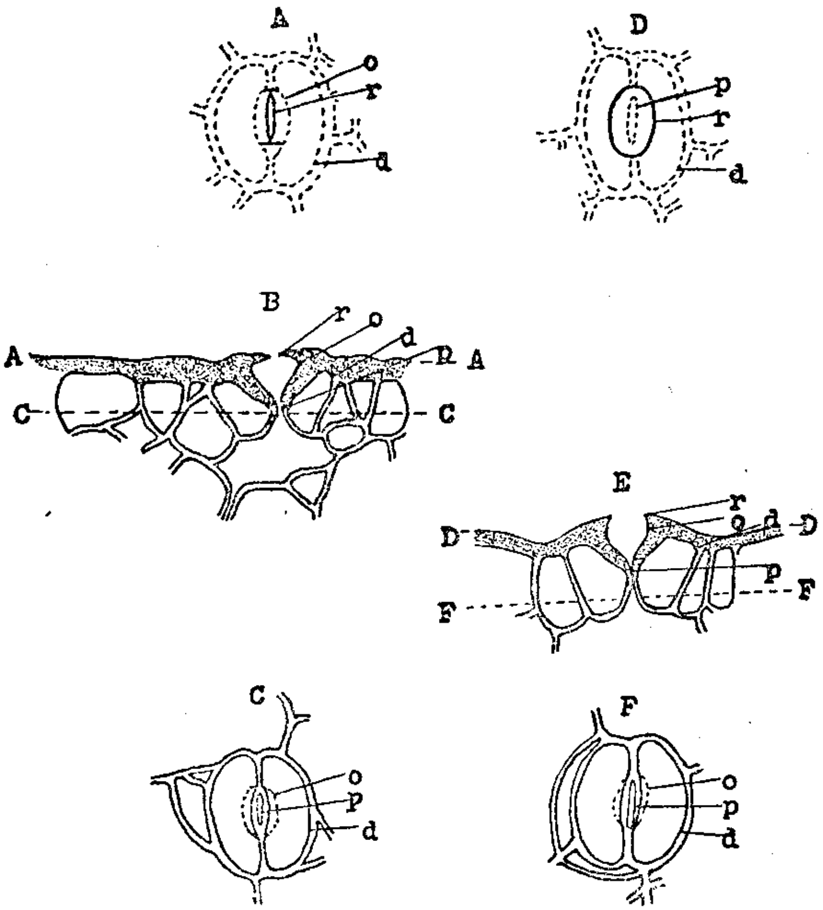

FIG. 2. A, B, and C, stomata of Szinkom mandarin orange, × 570: A, surface view; B, median cross section: C, underview. Showing ridge of entrance, *r;* outer chamber, *o;* pore, *p;* and dorsal wall of guard cells, *d.* D, E, and F, stomata of Florida seedling grapefruit, × 570, showing same parts as A, B, and C.

permitting the entrance of the canker bacteria. Text fig. 2 shows these stomatal differences; the figure is taken from the senior writer's paper previously mentioned.[6]

[6] McLean, Forman T., A study of the structure of the stomata of two species of Citrus in relation to citrus canker, Bull. Torrey Bot. Club 48 (1921) 101–106.

SUMMARY

1. A method is outlined of applying measurable pressure to *Citrus* leaves and determining by this means the pressures necessary to cause penetration of such tissues by water.

2. Leaves of Szinkom mandarin orange, Washington navel orange, seedling East Indian pummelo, and Pernambuco grapefruit were tested by this method to determine their comparative injection pressure with water.

Tests of the injection pressures of *Citrus* leaves gave the following results: The average pressure for Pernambuco grapefruit was 19.5 centimeters of mercury; seedling East Indian pummelo, 19.6; Washington navel orange, 20.8; and Szinkom mandarin orange, 33.6.

3. The average injection pressures of the above four varieties are directly proportional to their canker resistance, as shown by field observations.

4. Leaves of Szinkom mandarin orange, a resistant variety of *Citrus*, and seedling grapefruit and pummelo trees, both very susceptible, were tested for their resistance to the entrance of canker organisms applied in water under pressure. Szinkom mandarin orange leaves were resistant to canker infection by immersion, and up to pressures of 10 centimeters of the mercury column. With high pressures numerous cankers developed in leaves of this variety. Grapefruit and pummelo leaves developed canker readily by immersion without added pressure.

The pressures necessary to cause canker infection were thus in agreement with the degree of observed field resistance of the sorts tested.

5. The results obtained strongly substantiate the theory previously advanced that structural differences in the stomata constitute one cause for the differences in susceptibility of the mandarin orange and the grapefruit and pummelo varieties. In the mandarin orange apparently the structure of the stomata prevents the ingress of surface water; in the grapefruit the stomatal structure is such as to allow the ingress of surface water which thus affords a medium of entrance for the canker bacteria.

6. The results definitely indicate that the resistance of the mandarin orange is due to mechanical structural differences.

ILLUSTRATIONS

TEXT FIGURES

THE SCHICK REACTION IN FILIPINOS

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FOUR PLATES

The Schick reaction consists of the injection of a certain amount of diphtheria toxin into the skin of a person in order to determine the presence of the corresponding antitoxin. The negative reaction indicates the presence of at least 1/30 to 1/20 of a unit of a diphtheria antitoxin per cubic centimeter of the blood serum, which amount is usually sufficient to protect the individual from an attack of diphtheria. The positive reaction indicates either a lower content or the total absence of antitoxin in the blood, and the individual is presumably susceptible to the disease.(8, 4) Therefore, the reaction is a means of determining the presence of antitoxic immunity, either natural or acquired, and it is now being widely used for the control of diphtheria contacts, and also as an index in the immunization of persons against the disease.

In a former paper (2) mention was made of the relative infrequency of diphtheria in the Philippine Islands in spite of the presence here of virulent diphtheria bacilli. It has been deemed of interest, therefore, to study the Schick reaction among Filipinos in order to obtain an idea of their immunity to the disease that may help to explain the relatively low incidence of the disease among them.

MATERIAL AND METHOD

The tests were performed on Filipinos, from infants 6 months old to adults of all ages, and at various times from October, 1919, to October, 1921. The cases tested were inmates of Government institutions; the baby nurseries at Singalong and Tondo, which gave us the material for infants and young children; the Government Orphanage at San Pedro Macati and the Boys' and Girls' Reformatories, where the inmates were children and boys and girls of school age; the San Lazaro Hospital Insane Asylum and Bilibid Prison, where the cases were adults of both sexes.

Two intradermal injections were made in the majority of the cases, one on the anterior surface of each forearm. On the right forearm the toxin was injected and on the left forearm the control.

The toxin used in our work was three years old, prepared by the Bureau of Science; the original minimum lethal dose was 0.01 cubic centimeter and at the time these tests were made it was 0.05 cubic centimeter as determined by repeated inoculation of guinea pigs weighing from 250 to 300 grams. The test dose was 0.02 minimum lethal dose diluted to 0.1 cubic centimeter with sterile physiological salt solution.

The control used was either toxin overneutralized with antitoxin in the proportion of 0.02 minimum lethal dose to 0.2 unit of antitoxin, the volume of the injection being made to 0.1 cubic centimeter by the addition of sterile physiological salt solution, or toxin 0.02 minimum lethal dose heated for five or ten minutes at 75° C. In many cases controlled by the injection of toxin heated for five minutes, both arms showed reactions, although in the control in some cases the reaction developed to a lesser degree, suggesting that five minutes' heating was not sufficient to destroy all the toxin. In these cases the test was repeated, using the control toxin heated for ten minutes.

The tests of the control solutions by intracutaneous injection in guinea pigs(7) showed reddening and œdema at the end of twenty-four hours at the site injected with 0.02 minimum lethal dose toxin heated to 75° C. for five minutes; the site of the injection of the toxin heated for ten minutes and that of the toxin-antitoxin mixture showed no changes, as compared with the œdema and necrosis produced by the intradermal injection of free unheated toxin.

In our first tests no control injections were made, but three months afterwards those that showed reaction were retested with corresponding control injections. Incidentally, as was to be expected, we found that the first injection of toxin was not sufficient to confer immunity, as is graphically shown in Plate 3.

By means of syringes graduated in hundredths, such as are usually employed in tuberculin injections, and fine platinum needles, the amount of the substance for the Schick test or the control was injected slowly into the skin, between the epidermis and the dermal layer, which produced a wheallike swelling with the pores of the skin made prominent. The injections were easily made and fairly accurate when the needles used were

sharp and were introduced with the beveled surface toward the epidermis, and when there were no leaks in the syringes.

INTERPRETATION OF THE REACTION

The positive Schick reaction was shown by the appearance around the site of injection of a clearly defined area of redness and infiltration which lasted more than one week, leaving more or less pigmentation which disappeared usually in about a couple of weeks. In some cases the reaction was so marked as to produce sudaminiform eruptions, superficial necrosis, and blisters which desquamated on drying and left deep pigmentations for a considerable length of time (Plates 1 to 3). The negative reaction was judged by the entire disappearance of the redness and tumefaction, due to traumatism of the injection, inside of two days, leaving at most a small pigmented point at the site of the entrance of the needle.

Pseudoreaction, which was manifested by a less-defined area of redness and infiltration, disappearing usually inside of two days, was frequently noted; in adult subjects it at times lasted longer, leaving a small reddish pigmented area at the end of one week which was difficult to distinguish, in many cases, from true reaction, unless the test was properly controlled (Plate 4). The pseudoreaction occurred very seldom in young children, and what positive reaction they showed was so typical that later on no control injections were made on children below 4 years of age, as they were considered unnecessary.

Inspection of the injections was usually made at the end of one, two, and three days, and one week, and the reactions that were considered doubtful were repeated, using different methods of control. There was no difficulty in passing judgment on strong positive reactions, but in those cases in which the reaction was weak or doubtful, careful comparison with control was made from day to day; and if, at the end of one week, the site of the unheated toxin definitely showed more pigmentation than the control, the reaction was considered positive.

SUMMARY AND DISCUSSION OF FINDINGS

The findings are shown in Table 1. In all 1,030 individuals of various ages were tested: 698 males and 332 females. Eighty-eight, or 8.5 per cent, of the 1,030 people examined were positive. The table shows that most of the positives were found during the first eight years of life, especially during early infancy and childhood. The number of positives de-

creased considerably from the age of 8 years up to the adult period. The females, as a general rule, showed a greater number of positive reactions than the males; they averaged 14 per cent of the total number of females examined, whereas the males only showed 5.8 per cent of positives. We also noted similarity in reaction in several groups of brothers and sisters in the Government Orphanage; and where differences were found, the younger ones gave the positive reactions.

TABLE 1.—*Schick reaction in Filipinos.*

Age.	Male.			Female.			Total.		
	Cases.	Positive.		Cases.	Positive.		Cases.	Positive.	
Years.		*Cases.*	*Per ct.*		*Cases.*	*Per ct.*		*Cases.*	*Per ct.*
Less than 1	7	5	71	3	1	33	10	6	60
1 to 2	7	5	71	2	1	50	9	6	66.6
2 to 4	10	3	30	6	4	66	16	7	43.7
4 to 6	16	5	31	4	2	50	20	7	35
6 to 8	9	1	11	20	6	30	29	7	24
8 to 10	30	0	0	20	3	15	50	3	6
10 to 12	57	1	1.7	20	0	0	77	1	1.3
12 to 14	102	2	1.9	37	6	15	139	8	5.7
14 to 16	163	7	4.2	25	3	12	188	10	5.3
16 to 18	95	5	5.2	16	3	19	111	8	7.1
18 and over	202	7	3.3	179	18	10	381	25	6.3
Total	698	41	5.8	332	47	14	1,030	88	8.5

Comparing our findings with those of other authors (Table 2) we find about the same figures as regards the percentage of positive reactions from the age of 8 years downward; but from 8 years upward there is a definite decrease of at least two-thirds in the number of persons showing positive reactions as compared with the results in other places. Assuming that the Schick reaction is an index of the susceptibility of individuals toward diphtherial infection, we must conclude that Filipino children are just as susceptible to diphtheria as are children in other places. Boys and girls of school age and adults, on the other hand, compared with individuals of the same age in Europe and America, are very much less susceptible to the disease.

The relatively low susceptibility of Filipinos as a whole cannot explain entirely the relatively rare incidence of diphtherial disease in the Philippines. Evidently there must be other factors that must be taken into consideration; for instance, climate and such other conditions as may also influence the relative infrequency in the Tropics of other diseases, such as serious respiratory disturbances, etc.

TABLE 2.—*Comparison of percentage of positive Schick reactions at various ages.*

Age.	Schick. (9)	Park, Zingher, and Serota. (6)	Moody. (5)	Kolmer and Moshage. (4)	Bundesen. (1)	Zingher. (11)	Wright (on Negroes. (10)	Johnson. (3)	Zingher (on soldiers). (12)	Gomez, Navarro, and Kapauan. (2)
Years.										
Under 1	10.2	40	33.3	12	28.3	----	----	76.6	----	60
1 to 2	63.3	65	55.5	43	60	----	----	50	----	66.6
2 to 4		66.8	64.5	66	50	32.2	----	66.6	----	43.7
4 to 6		50	56.5	58	45	25.7	----	66.6	----	35
6 to 8		35.1	44.3	57	34	21.8	----	40	----	24
8 to 10	49.5				36.6	22.6	----		----	6
10 to 12		26	39	24	39	21.4	----	30	----	1.3
12 to 14					39.6	17.7	----		----	5
14 to 16	----					16.4	----		----	5
16 to 18	----	33	26.6	37.2	41.5	----	----	26	----	7.1
18 or over	----					----	43		16.6	6.3

We desire to express to Dr. José Fabella, of the Public Welfare Board; Dr. Lorenzo C. Reyes, of the City of Manila; and Dr. Henry Pick, of Bilibid Prison, our appreciation of the courtesies extended to us during the performance of these tests in the institutions under their respective care.

REFERENCES

1. BUNDESEN, HERMAN N. The Schick reaction with a report of eight hundred cases. Journ. Am. Med. Assoc. **64** (1915) 1203.
2. GOMEZ, LIBORIO; KAPAUAN, AMANDO M.; and GAVINO, CATALINO. Diphtheria in the Philippine Islands. Philip. Journ. Sci. **17** (1920) 37.
3. JOHNSON, A. C. The results of the Schick test for diphtheria susceptibility in five hundred selected cases. Med. Record **94** (1918) 498.
4. KOLMER, J. A., and MOSHAGE, E. L. The Schick toxin reaction for immunity in diphtheria. Am. Journ. Dis. Childr. **9** (1915) 189.
5. MOODY, E. E. The intradermic diphtheria toxin test. Journ. Am. Med. Assoc. **64** (1915) 1206.
6. PARK, WILLIAM H.; ZINGHER, A.; and SEROTA, N. M. The Schick reaction and its practical application. Arch. Pediatrics **31** (1914) 481.
7. ROMER, PAUL H. Ueber den Nachweis sehr kleiner Mengen des Diphtheriegiftes. Zeitschr. f. Immunitätforsch. **3** (1909) orig. 208.
8. SCHICK, B. Spezifische Therapie der Diphtherie. Centralbl. f. Bakt. **57**[1] (1913) Ref. 16.
9. SCHICK, B. Die Diphtherietoxin-Hautreaktion des Menschen als Vorprobe der prophylaktischen Diphtherieheilseruminjektion. Münchener med. Wochenschr. **60** (1913) 2608.
10. WRIGHT, L. T. The Schick's test with especial reference to the Negro. Journ. Infect. Dis. **21** (1917) 265.
11. ZINGHER, A. Methods of using diphtheria toxin in the Schick's test and of controlling the reaction. Am. Journ. Dis. Childr. **11** (1916) 264.
12. ZINGHER, A. Interpretation of the Schick reaction in recruits for the National Army. Journ. Am. Med. Assoc. **70** (1918) 227.

ILLUSTRATIONS

[Photographs by E. Cortes.]

PLATE 1

FIG. 1. Typical Schick reaction, three days after injection. L.M., Filipino, female, 6 years old. Right arm (upper) injected with 0.02 minimum lethal dose toxin and left arm (lower) injected with a mixture of 0.02 minimum lethal dose toxin and 0.2 unit of antitoxin. Photographed on January 17, 1920.

2. The right arm of the case shown in fig. 1, thirteen days after the injection, showing especially the scaling after a positive Schick reaction. The injection was performed on January 14, 1920, and the photograph was taken on January 27, 1920.

PLATE 2

FIG. 1. Bleb formation in Schick reaction, three days after injection. Above is J.M., Filipino, male, 11 years old and below is D.Y., Filipino, female, 14 years old. Photographed on October 20, 1920.

2. Pigmentation after bleb formation in Schick reaction. Same cases as fig. 1, three months after injection. Injected October 17, 1919, and this photograph was taken on January 17, 1920.

PLATE 3

FIG. 1. Repeated Schick test. G.S., Filipino, male, 39 years old, photographed on January 27, 1920. The dark area toward the elbow is the pigmentation that was left by a previous positive Schick test (October 9, 1919). The small dark area toward the wrist shows the appearance of the second reaction four days after the injection.

2. Typical Schick reaction. C.G., Filipino, female, 37 years old. Right arm injected with 0.02 minimum lethal dose unheated toxin and left arm with 0.02 minimum lethal dose toxin heated to 75° C. for five minutes the first time and ten minutes the second time. First test injected on October 17 and second test on October 25, 1921. Photographed on October 28, 1921. Notice the pigmentation (the site nearer the elbow) that remained eleven days after the first injection, and the beginning desquamation of the skin (the site farther from the elbow) three days after the second injection. The control arm shows no marks whatever, after receiving toxin heated for five minutes in the first test and for ten minutes in the second test.

PLATE 4

FIG. 1. Pseudoreaction. Right forearm of F.A., Filipino, female, 12 years old. Injected 0.02 minimum lethal dose diphtheria toxin intracutaneously on December 18, 1919. Photograph taken twenty-eight hours after the injection.

2. Pseudoreaction three days and eleven days after injection. B.M., Filipino, female, 24 years old. Right forearm injected with 0.02 minimum lethal dose unheated toxin. Left forearm injected on the outer side with the same amount of toxin heated to 75° C. for five minutes, and on the inner side with toxin heated to 75° C. for ten minutes. Smaller marks are due to pigmentation (on site near the elbow on the right forearm and on the outer side on the left forearm), which remained after the first test October 17, 1921; larger marks on the farther side from the elbow on the right forearm and on the inner side on the left forearm produced by inflammation from the second test October 25, 1921. Photographed on October 28, 1921.

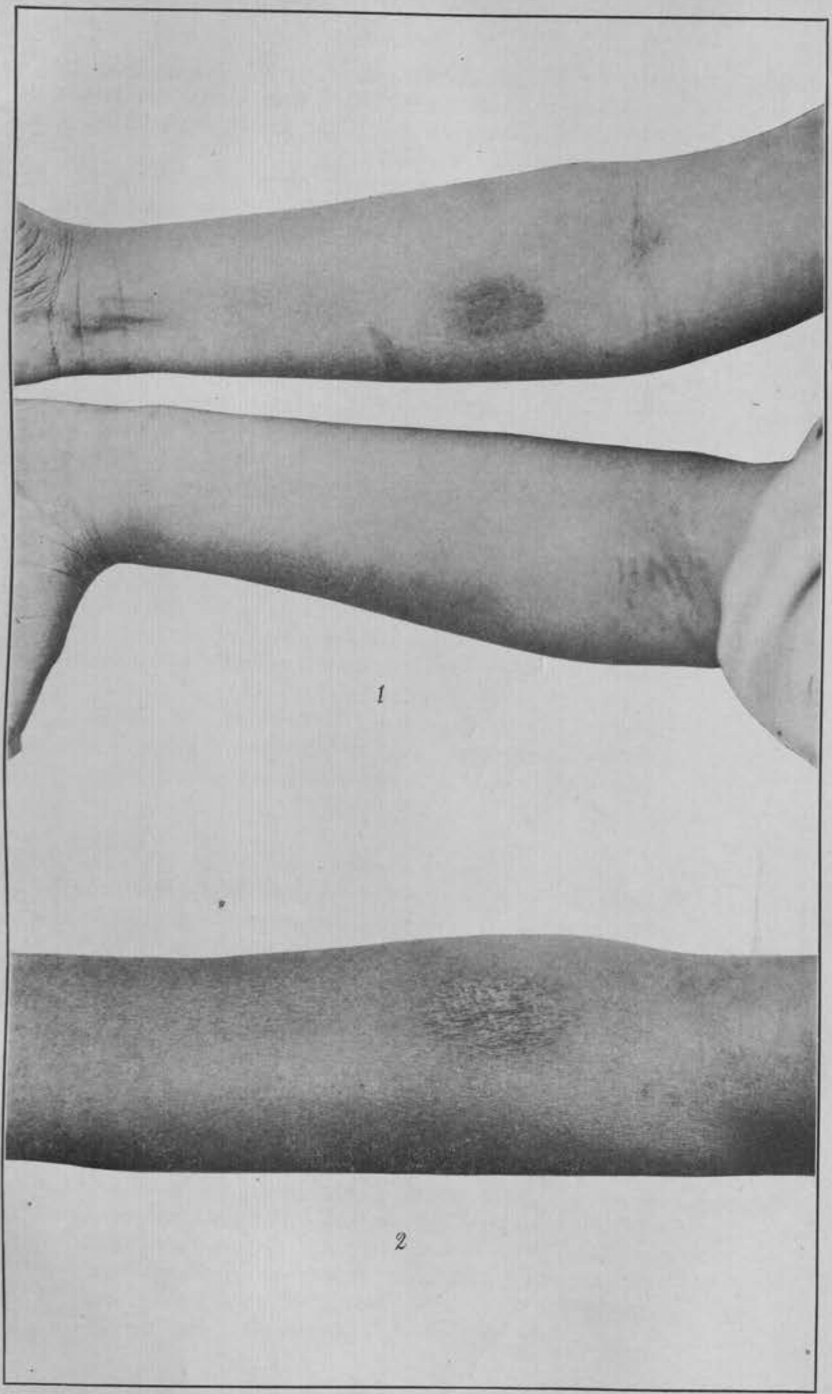

PLATE 1.

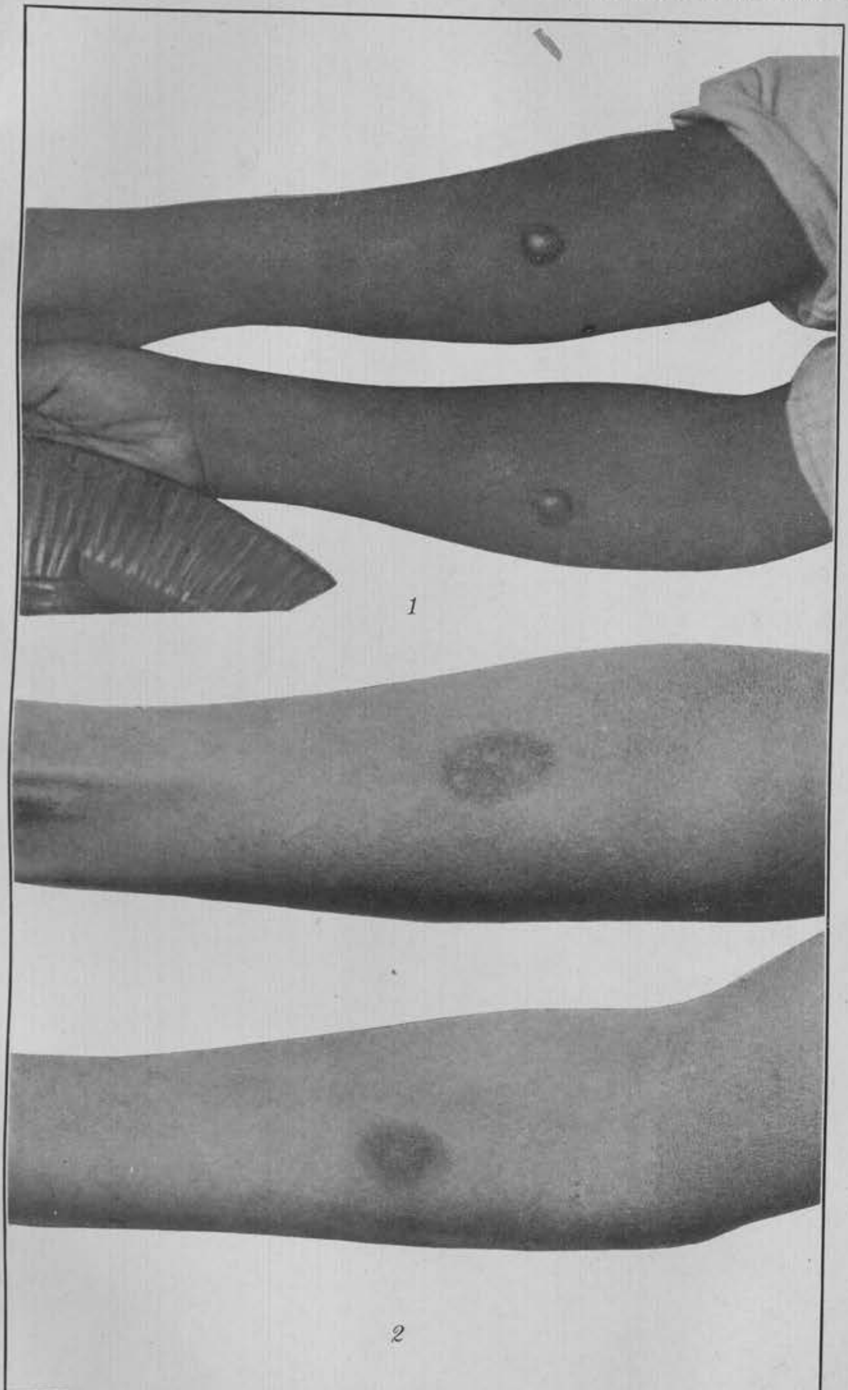

PLATE 2.

1

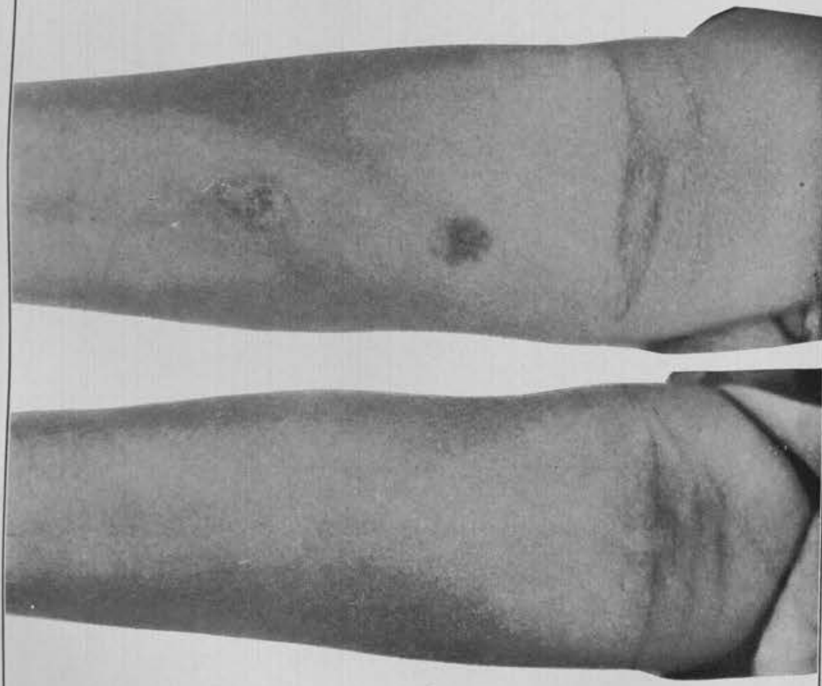

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PLATE 3.

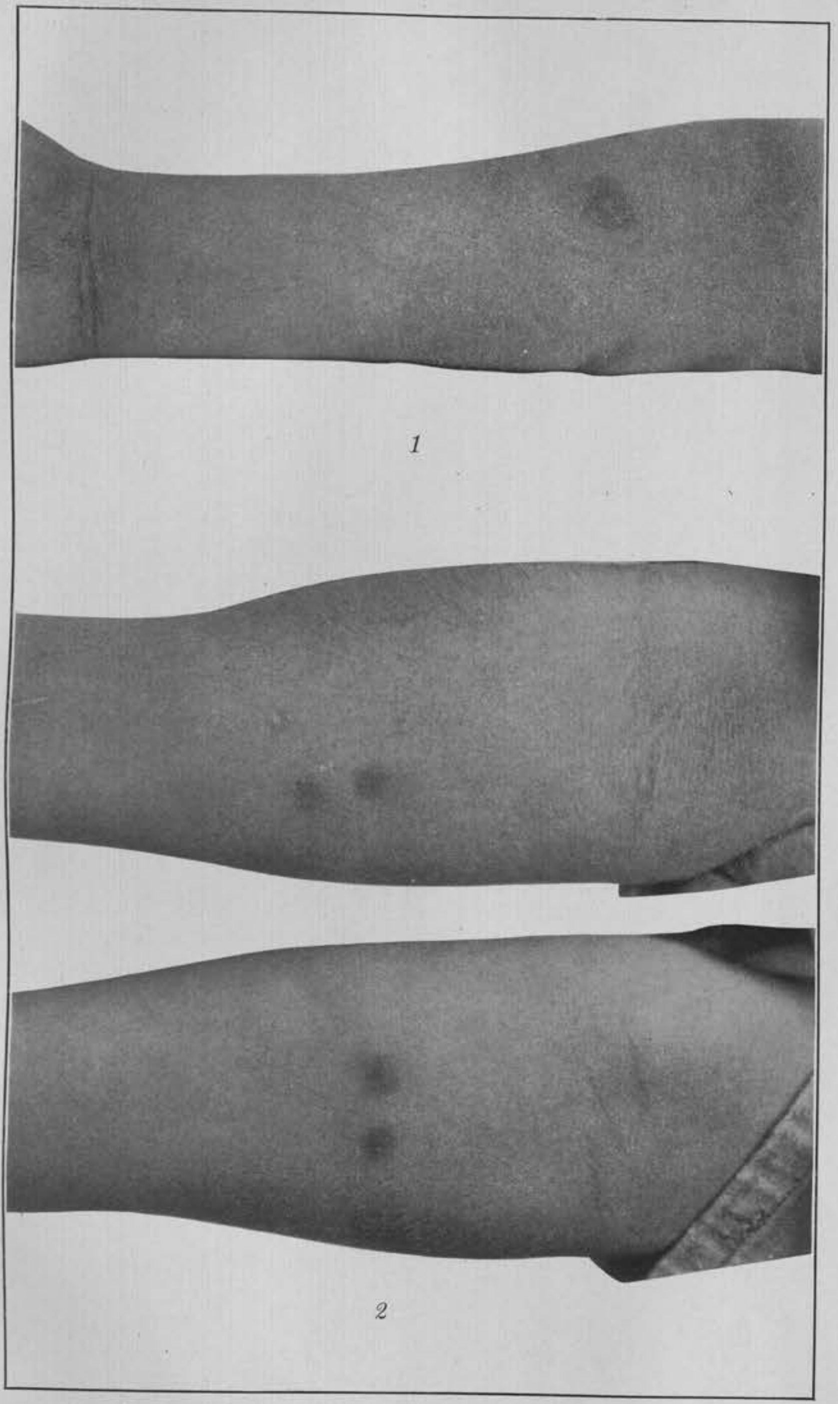

PLATE 4.

RELATION OF THE AGE OF CITRUS TISSUES TO THE SUSCEPTIBILITY TO CITRUS CANKER

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FOUR PLATES AND ONE TEXT FIGURE

INTRODUCTION

The writer has previously shown that there is an increase in resistance to the plant disease citrus canker with the advance in maturity of citrus trees.[1] In the present paper experiments are presented which indicate that local tissues of citrus plants, both foliage and fruit, also increase in resistance as they approach maturity.

The purpose of the experiments was to inoculate fruits of different degrees of maturity, using identical cultures and maintaining identical environmental conditions, and measuring the amounts of canker resulting at such different stages of maturity. Similar experiments were carried out on foliage.

EXPERIMENTAL RESULTS

Preliminary experiments were begun on fruits of the pineapple orange (*Citrus sinensis*) in the Philippines. The pineapple orange variety is of Florida origin and grown to some extent commercially in that state. Fruits on vigorous, actively growing orchard trees were selected in varying stages of maturity as measured by their size. The fruits were inoculated from the same infusion of cultures of the citrus-canker organism, *Pseudomonas citri*, and maintained under identical environmental conditions favorable for canker formation. The results are shown in Table 1.

The data in Table 1 show that there is a very considerable susceptiblity for fruits of a small diameter, while large fruits approaching maturity were but slightly affected by canker, if at

[1] Lee, H. Atherton, The increase in resistance to citrus canker with the advance in maturity of citrus trees, Phytopathology 11 (1921) 70.

all. In other words, apparently there was a lessening of susceptibility with increasing maturity. The experiment was repeated on fruits of the Valencia orange, using the same methods.

TABLE 1.—*Results of inoculation with Pseudomonas citri by twenty needle punctures on pineapple orange fruits of various degrees of maturity, as measured by their size.*

[Date of inoculation May 25, 1918; date of observation of results June 8, 1918.]

Fruit.			Results; infections.	
No.	Diameter.	Condition.	At punctures.	Not at punctures.
	mm.		*Per cent.*	*Number.*
1	19		90	78
2	19		100	(a)
3	25		100	41
4	25		100	18
5	29		100	10
6	32		100	8
7	32		100	16
8	32		80	3
9	32		90	6
10	32		90	5
11	32		80	1
12	44		80	1
13	50		50	0
14	50		30	0
15	57	Still green	[b] 0	0
16	57	do	5	0
17	57	do	[b] 0	0
18	57	do	[b] 0	0
19	57	do	60	0
20	63	do	[b] 0	0
21	69	do	0	0

[a] Numerous.

[b] In these cases a reaction was produced as indicated by a yellow halo around the punctures; nevertheless no excrescence was formed, and it could not be said that cankers were present.

The results shown in Table 2 for the Valencia orange are in entire agreement with those shown in Table 1 on the pineapple orange. Plate 1 shows the difference in the results obtained from fruits of different degrees of maturity.

The experiments were then continued in Nagasaki Prefecture, Japan, on fruits of the Washington navel orange. In this case, however, it was possible to carry out the experiments throughout the whole growing season. Fruits were inoculated at the time of the dropping of the petals in late May and early June, and thereafter at different periods during their development toward maturity. It was thus possible to use fruits of a known

TABLE 2.—*Results of inoculation with Pseudomonas citri by twenty needle punctures on Valencia orange fruits of various degrees of maturity, as measured by their size.*

[Date of inoculation June 4, 1918; date of observation June 22, 1918.]

Fruit.			Results; infections.	
No.	Diameter.	Condition.	At punctures.	Not at punctures.
	mm		*Per cent.*	*Number.*
1	25		90	10
2	25		100	75
3	25		100	40
4	48		45	30
5	50	Approaching maturity	55	0
6	50	do	0	1
7	50	do	0	0
8	50	do	0	0
9	52	do	0	0
10	52	do	0	0

TABLE 3.—*Results of inoculation with Pseudomonas citri on Washington navel orange fruits of various degrees of maturity.*

Fruit.			Needle punctures.	Infections.	
No.	Age.[a]	Diameter.		At punctures.	Not at punctures.
	Days.	*mm.*		*Per cent.*	*Number.*
1	2	8.0	0		Fruit dropped.
2	2	6.5	0		Do.
3	2	9.5	0		Do.
4	2	8.0	0		Do.
5	2	8.0	0		Mass of cankers.
6	2	11.0	0		Fruit dropped.
7	2	8.0	0		Mass of cankers.
8	2	8.0	0		Fruit dropped.
9	2	6.5	0		Do.
10	2	8.0	0		Do.
11	2	9.5	10		Do.
12	2	11.0	10	100	150+
13	2	8.0	10		Fruit dropped.
14	2	11.0	10		Do.
15	2	8.0	10		Do.
16	2	8.0	10		Do.
17	2	8.0	10		Do.
18	2	8.0	10	100	Mass of cankers.
19	2	6.5	10		Fruit dropped.
20	2	6.5	10		Do.
21	15	16.0	0		Do.
22	15	11.0	0		Do.

[a] It is difficult to determine practically the period at which the ovary of the flower becomes a fruit; in this case, fruits 1 to 20 were inoculated but one or two days after the petals had dropped.

TABLE 3.—*Results of inoculation with Pseudomonas citri on Washington navel orange fruits of various degrees of maturity*—Continued.

Fruit.			Needle punctures.	Infections.	
No.	Age.[a]	Diameter.		At punctures.	Not at punctures.
	Days.	*mm.*		*Per cent.*	*Number.*
23	15	9.5	0	----------	Fruit dropped.
24	15	14.5	0	----------	100+
25	15	16.0	0	----------	Fruit dropped.
26	15	14.5	0	----------	100+
27	15	13.0	0	----------	Fruit dropped.
28	15	19.0	0	----------	Do.
29	15	14.5	0	----------	Do.
30	15	11.0	0	----------	100+
31	30	13.0	0	----------	300+
32	30	24.0	0	----------	400+
33	30	19.0	0	----------	Mass of cankers.
34	30	13.0	0	----------	Do.
35	30	22.5	0	----------	Do.
36	30	16.0	0	----------	Do.
37	30	22.5	0	----------	Do.
38	30	17.5	0	----------	Do.
39	30	14.5	0	----------	Fruit dropped.
40	30	21.0	0	----------	Mass of cankers.
41	44	38.0	0	----------	200+
42	44	28.5	0	----------	49
43	44	32.0	0	----------	70
44	44	22.5	0	----------	Fruit dropped.
45	44	35.0	0	----------	100+
46	44	25.5	0	----------	Fruit dropped.
47	44	28.5	0	----------	Mass of cankers.
48	44	14.5	0	----------	Do.
49	44	25.5	0	----------	Do.
50	44	28.5	0	----------	Do.
51	55	38.0	0	----------	100+
52	55	41.5	0	----------	100+
53	55	44.5	0	----------	33
54	55	35.0	0	----------	Mass of cankers.
55	55	41.5	0	----------	50
56	55	44.5	20	100	100+
57	55	35.0	20	100	Mass of cankers.
58	55	43.0	20	100	34
59	55	41.5	20	100	33
60	55	38.1	20	100	52
61	86	50.0	0	----------	1
62	86	57.0	0	----------	None.
63	86	44.0	0	----------	2
64	86	57.0	0	----------	4
65	86	50.0	0	----------	14
66	86	48.0	20	80	1
67	86	50.0	20	40	7

[a] It is difficult to determine practically the period at which the ovary of the flower becomes a fruit; in this case, fruits 1 to 20 were inoculated but one or two days after the petals had dropped.

TABLE 3.—*Results of inoculation with Pseudomonas citri on Washington navel orange fruits of various degrees of maturity*—Continued.

Fruit.			Needle punctures.	Infections.	
No.	Age.[a]	Diameter.		At punctures.	Not at punctures.
	Days.	*mm.*		*Per cent.*	*Number.*
68	86	57.0	20	90	4
69	86	50.0	20	90	6
70	86	48.0	20	95	None.
71	101	60.0	20	100	Do.
72	101	56.0	20	100	4
73	101	50.0	20	100	2
74	101	57.0	20	100	None.
75	101	52.0	20	100	Do.
76	101	63.0	0	----------	Do.
77	101	66.0	0	----------	Do.
78	101	54.0	0	----------	Do.
79	101	54.0	0	----------	Do.
80	101	50.0	0	----------	Dc.
81	117	46.0	20	0	Do.
82	117	50.0	20	([b])	Do.
83	117	50.0	20	[c]25	Do.
84	117	48.0	20	[c]25	Do.
85	117	50.0	20	[c]40	Do.
86	117	52.0	20	[c]40	Do.
87	117	48.0	20	[c]25	Do.
88	117	50.0	20	[c]60	Do.
89	117	48.0	20	[c]60	Do.
90	117	48.0	20	[c]60	Do.
91	130	69.0	20	0	Do.
92	130	66.0	20	0	Do.
93	130	66.0	20	0	Do.
94	130	69.0	20	0	Do.
95	130	69.0	20	[c]4	Do.
96	130	76.0	0	0	Do.
97	130	63.0	0	0	Do.
98	130	69.0	0	0	Do.
99	130	63.0	0	0	Do.
100	130	66.0	0	0	Do.

[a] It is difficult to determine practically the period at which the ovary of the flower becomes a fruit; in this case, fruits 1 to 20 were inoculated but one or two days after the petals had dropped.

[b] Fruit lost.

[c] Although these punctures are recorded as yielding positive results, nevertheless the only reaction obtained was a yellow discoloration without actual canker formation. From an orange grower's viewpoint no canker resulted.

age as well as to approximate their stages of maturity by their sizes. Throughout the season similar technic was used for the inoculation, and the inoculum was always obtained from 7- to 10-day potato cylinder cultures. All inoculations were maintained under identical environmental conditions. The results are recorded in Table 3.

The data contained in Table 3 rather definitely indicate an increasing resistance of fruit tissues as they matured. It may be stated even more strongly that the tissues became immune with maturity. Some of the striking results obtained are shown in Plates 1, 2, and 3.

Paralleling the experiments upon the Washington navel variety, tests were made upon fruits of the Ikiriki strain of the Unshiu (Satsuma) orange (*Citrus nobilis* var. *unshiu.*) The petals of the blossoms of this variety drop at about the same time as those of the Washington navel orange, although the flowers of the Unshiu orange sometimes extend a week or ten days later

TABLE 4.—*Results of inoculation with Pseudomonas citri on Unshiu orange fruits of various degrees of maturity.*

Fruit.			Needle punctures.	Infections.	
No.	Age.[a]	Diameter.		At punctures.	Not at punctures.
	Days.	*mm.*		*Per cent.*	*Number.*
1	2	6.4	10		Fruit dropped.
2	2	4.8	10		Do.
3	2	8.0	10	10	
4	2	11.2	10	30	
5	2	6.4	10	5	
6	2	8.0	10		Fruit dropped.
7	2	9.6	10	75	
8	2	12.8	10		Fruit dropped.
9	2	9.6	10	0	
10	2	8.0	10	5	
11	2	12.8	0		11
12	2	9.6	0		Numerous.[b]
13	2	8.0	0		11
14	2	9.6	0		Fruit dropped.
15	2	9.6	0		9
16	2	12.8	0		18
17	2	12.8	0		3
18	2	8.0	0		5
19	2	8.0	0		Fruit dropped.
20	2	9.6	0		Do.
21	2	8.0	0		None.
22	2	8.0	0		Fruit dropped.
23	2	6.4	0		Do.
24	2	8.0	0		2
25	2	8.0	0		6
26	2	8.0	0		8
27	2	8.0	0		4

[a] As with the Washington navel fruits, it was very difficult to determine for practical purposes the stage at which the ovary of the flower became a fruit. In the present case fruits 1 to 20 were inoculated but one or two days after the flower petals had fallen.

[b] The term numerous was used only in the case of an observation of a fruit in which the cankers were so many as to form a mass of lesions difficult to identify strictly and count definitely.

TABLE 4.—*Results of inoculation with Pseudomonas citri on Unshiu orange fruits of various degrees of maturity*—Continued.

Fruit.			Needle punctures.	Infections.	
No.	Age.[a]	Diameter.		At punctures.	Not at punctures.
	Days.	*mm.*		*Per cent.*	*Number.*
28	2	6.4	0	----------	Fruit dropped.
29	2	11.2	0	----------	11
30	2	9.6	0	----------	18
31	24	16.0	10	----------	Fruit dropped.
32	24	16.0	10	----------	Do.
33	24	19.2	10	100	Numerous.
34	24	11.2	10	----------	Fruit dropped.
35	24	16.0	10	----------	Do.
36	24	20.8	10	100	Numerous.
37	24	22.4	10	----------	Fruit dropped.
38	24	23.8	10	100	Numerous.
39	24	12.8	10	----------	Fruit dropped.
40	24	19.2	10	----------	Do.
41	24	19.2	0	----------	Do.
42	24	12.8	0	----------	Do.
43	24	9.6	0	----------	Numerous.
44	24	24.0	0	----------	Fruit dropped.
45	24	16.0	0	----------	Numerous.
46	24	22.4	0	----------	Do.
47	24	22.4	0	----------	Do.
48	24	20.8	0	----------	Do.
49	24	22.4	0	----------	Do.
50	24	16.0	0	----------	Do.
51	54	35.0	0	----------	45
52	54	31.8	0	----------	5
53	54	33.4	0	----------	5
54	54	35.0	0	----------	Numerous.
55	54	31.8	0	----------	28
56	54	36.6	20	30	3
57	54	35.0	20	25	None.
58	54	44.2	20	15	3
59	54	30.2	20	80	8
60	54	31.8	20	0	3
61	98	50.8	20	0	None.
62	98	47.8	20	(c)	
63	98	44.2	20	0	None.
64	98	47.8	20	0	Do.
65	98	50.8	20	0	Do.
66	98	33.8	0	----------	Do.
67	98	47.8	0	----------	Do.
68	98	57.2	0	----------	Do.
69	98	47.8	0	----------	Do.
70	98	47.8	0	----------	Do.

[a] As with the Washington navel fruits, it was very difficult to determine for practical purposes the stage at which the ovary of the flower became a fruit. In the present case fruits 1 to 20 were inoculated but one or two days after the flower petals had fallen.

[c] Fruit lost.

into the season than the navel orange, in this district. These experiments were also carried on in Nagasaki Prefecture, Japan. The technic, sources of inoculum, and maintenance of inoculated fruits were the same as for the Washington navel fruit inoculations. The results are recorded in Table 4.

Stomatal infections obtained on the Unshiu orange fruits are shown in Plate 4. It is apparent from the results in Table 4 that there is a period during which Ikiriki Unshiu orange fruits have a considerable degree of susceptibility. Similar experiments were carried on upon the Owari Unshiu orange, the Zairai Unshiu orange, and the Wase Unshiu orange, in which the susceptibility varied but little, but in which the period of susceptibility was somewhat shorter than in the case of the Ikiriki orange, usually not more than seventy days. There is apparently a much shorter period of susceptibility in the case of these varieties than is the case with the Washington navel orange. The total period of possible infection is not more than ninety-eight days for the Unshiu oranges, as compared with one hundred fifteen to one hundred twenty days for the Washington navel orange.

There are further but less systematic data which point to a longer period of susceptibility for fruit tissues of the grapefruit [*Citrus maxima* (*decumana*)] than for either the Washington navel orange or the Unshiu orange. The differences in length of the periods of susceptibility of these species is well illustrated in the graph, fig. 1.

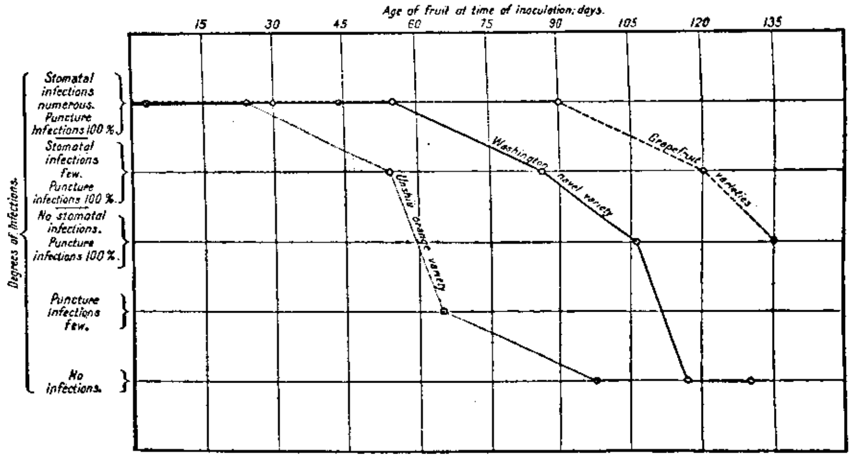


FIG. 1. Graphs showing the differences in lengths of periods of susceptibility of three commercial citrus varieties. The line of the period of susceptibility of the grapefruit varieties is not based on actual ages of the fruits, but the estimated ages judged by their sizes.

It is of less immediate practical importance, and much more difficult, to obtain exact data on the increase in resistance with advance in maturity of foliage tissues. The difficulty is, in the main, in obtaining a criterion of the degree of maturity of a leaf.

The data obtained have been from Washington navel leaves classed as (*a*) young, actively growing; (*b*) size fully developed but leaf still glossy, and the color only slightly deepened; and (*c*) fully matured and hardened leaves. The experimental results from similar infusions with identical technic and maintenance of inoculations indicate that, as the leaves become fully developed in size, the amounts of infection obtained, both with needle punctures and as stomatal infections, are very much lessened. Leaves become entirely resistant when they reach the size of maturity.

DISCUSSION OF RESULTS

The results obtained from the foregoing experiments apparently would warrant the statement, in conclusion, that the susceptibility of fruit and foliage tissues decreases with their advance toward maturity.

These results and conclusions are very intimately connected with field practices in preventing citrus canker. As the writer has pointed out in a paper now in press the problem of canker control on the moderately susceptible hosts, from the growers' viewpoint, may be narrowed to the prevention of fruit infections. The fruits of the Washington navel orange form in late May or June in western Japan. The period of susceptibility for such fruits in this district, as shown in Table 3, extends over possibly eighty-five days, during which stomatal infections are probable. After this age the fruits are but slightly susceptible to stomatal infection, although infections at wounds and injuries may take place in a large percentage of the chances until one hundred ten to one hundred twenty days. Thereafter, in this district, fruits of this variety are, for all practical purposes, immune. It would follow that preventive methods may largely be confined to the period of June, July, and August in the district where the results here reported were obtained.

The data on the susceptibility of the Unshiu orange are of less interest in local canker prevention because lesions upon this fruit are small, scarcely noticeable and, as observed in the seasons of 1918 and 1919, not at all common in Japan. Canker upon fruits of this variety, therefore, is almost negligible from the Japanese growers' viewpoint.

ILLUSTRATIONS

Plate 1

FIG. 1. Fruits of the Valencia orange; above, inoculated with *Pseudomonas citri* and twenty needle punctures giving 100 per cent positive results; below, fruits more nearly mature, inoculated by the same methods and the same culture, giving entirely negative results.

2. Fruits of the Washington navel orange inoculated with *Pseudomonas citri* when 44 days old, showing numerous stomatal infections and the stunted size of the fruits.

Plate 2

FIG. 1. A fruit of the Washington navel orange inoculated with *Pseudomonas citri* when 55 days old, showing stomatal infections as well as 100 per cent infection at needle punctures.

2. A fruit of the Washington navel orange inoculated with *Pseudomonas citri* when 86 days old, showing no stomatal infections but 100 per cent infection at needle punctures.

Plate 3

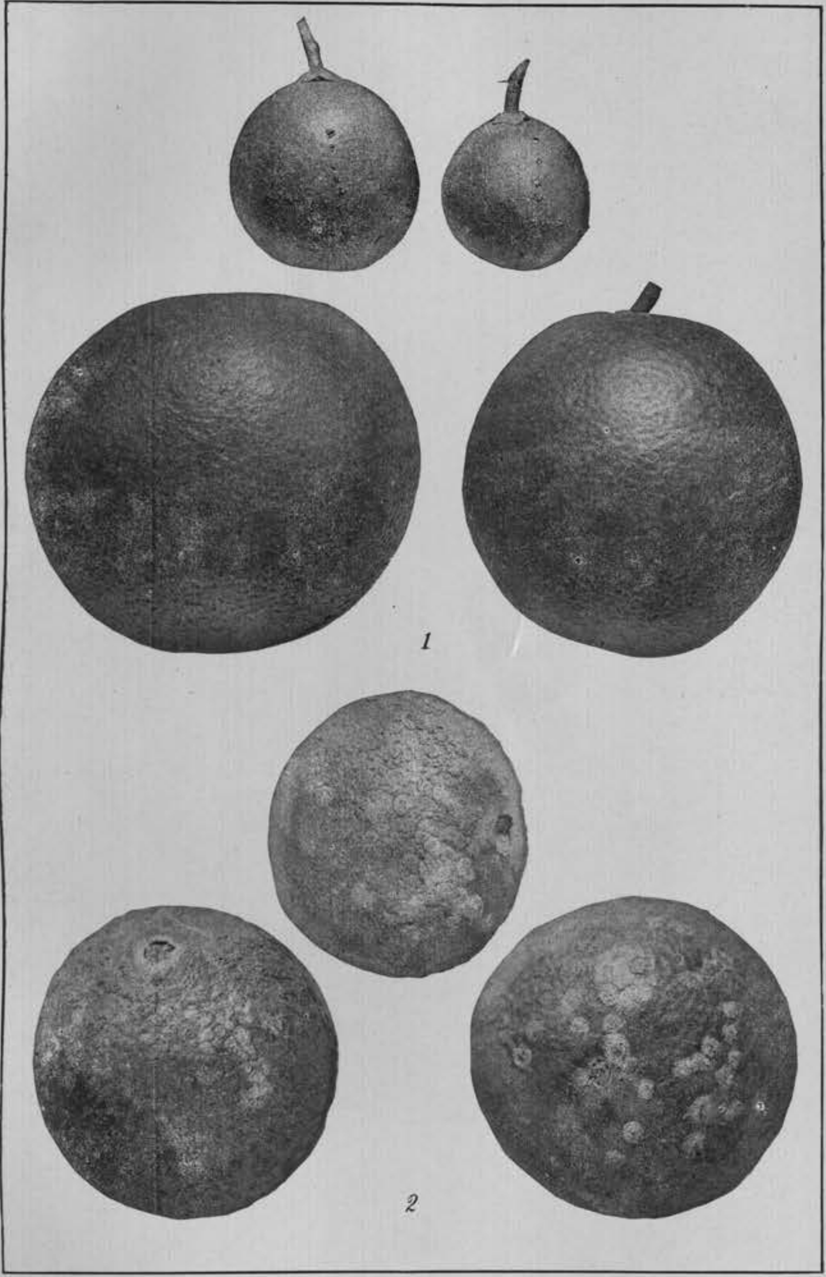
Fruits of the Washington navel orange, each inoculated with *Pseudomonas citri* and twenty needle punctures when 130 days old, showing the entirely negative results.

Plate 4

Fruits of the Ikiriki Unshiu (Satsuma) orange inoculated without needle punctures when 40 days old, showing the numerous stomatal infections and their atypical character.

TEXT FIGURE

FIG. 1. Graphs showing the differences in lengths of periods of susceptibility of three commercial citrus varieties.



Oranges inoculated with Pseudomonas citri. Fig. 1. Valencia oranges, above giving 100 per cent positive results; below, more nearly mature fruits giving negative results. 2. Washington navel oranges inoculated when 44 days old, showing stomatal infections and stunted size.

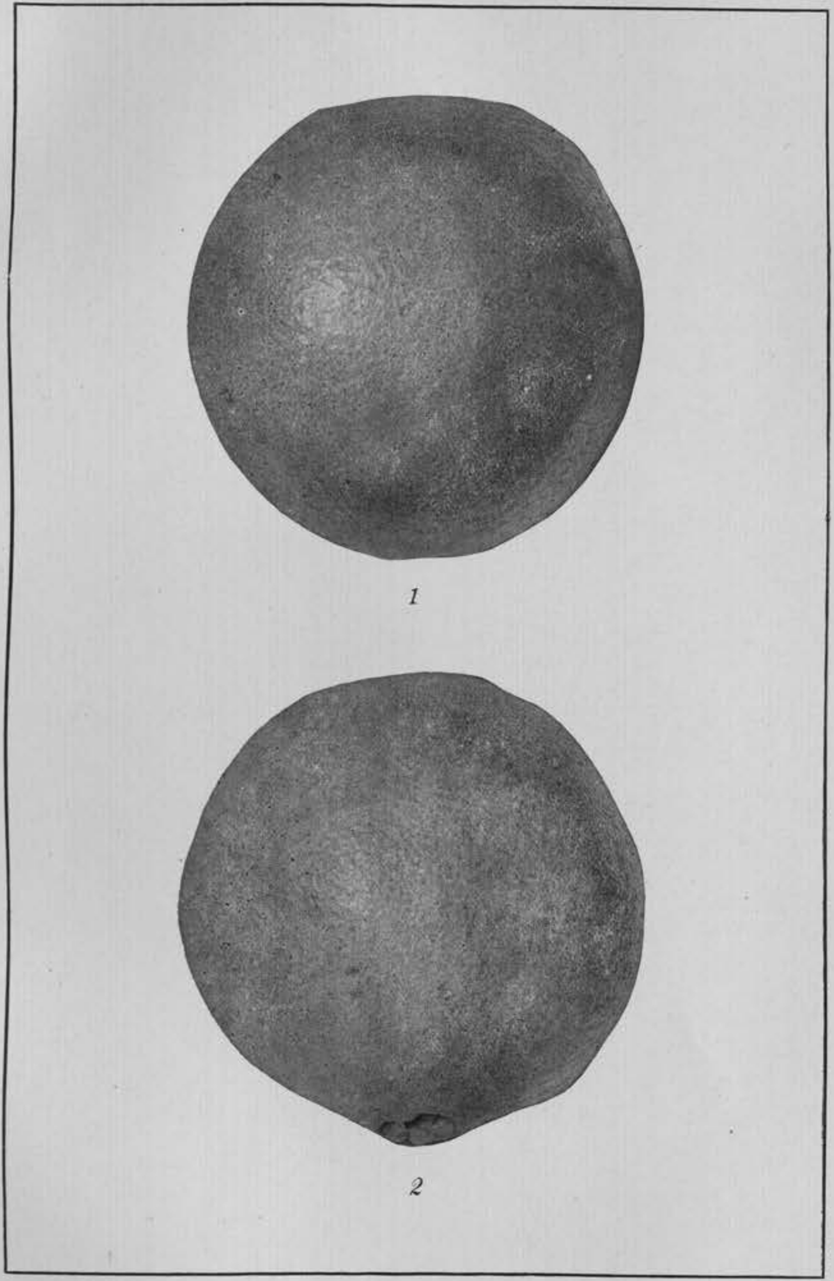
PLATE 1.

1

2

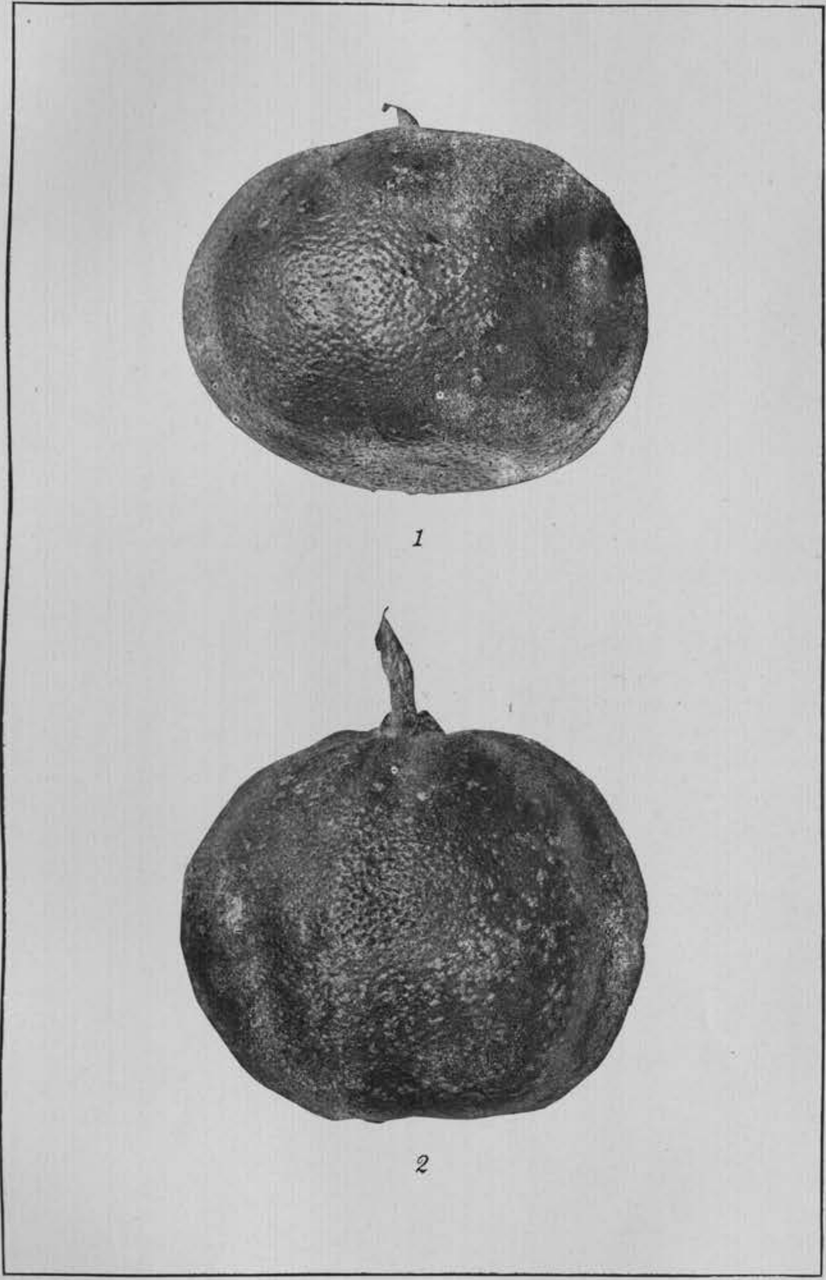
Washington navel oranges inoculated with Pseudomonas citri. Fig. 1. A fruit 55 days old, showing stomatal infections and 100 per cent infection at needle punctures. 2. A fruit 86 days old, showing no stomatal infection but 100 per cent infection at needle punctures.

PLATE 2.



Washington navel oranges, each inoculated with Pseudomonas citri and twenty needle punctures when 130 days old, showing the entirely negative results.

PLATE 3.



Ikiriki Unshiu (Satsuma) oranges inoculated without needle punctures when 40 days old, showing the numerous stomatal infections and their atypical character.

PLATE 4.

A MOUNTED SPECIMEN OF THE MONKEY-EATING EAGLE (PITHECOPHAGA JEFFERYI) OF THE PHILIPPINES

By R. W. SHUFELDT

Washington, D. C.

ONE PLATE

Being engaged at the present time upon a brief life history of the gannets (Sulidæ) I communicated with Mr. J. H. Gurney, the author of the splendid volume on those birds, to ascertain whether he could furnish me with a few facts in regard to them that may not have appeared in his book. To my great delight the request brought me far more than I anticipated, as my readers will appreciate later. With the material Mr. Gurney was so good as to send me, he generously inclosed a fine photograph of the monkey-eating eagle of the Philippines, *Pithecophaga jefferyi* Grant. This picture is of the mounted specimen that forms a part of the series of the birds of prey in the Norwich Museum, at Norwich, England, of which institution Mr. Gurney is director.

Some time ago I published a full account of the skeleton of this species,[1] so it is with exceptional pleasure that I am enabled to offer here such an excellent figure of the bird as the Norwich Museum specimen furnishes. Comparatively few among us have seen specimens of this species, and still fewer have enjoyed studying this giant among the eagles in nature; so I feel pretty sure that the illustration here reproduced will be appreciated.

This eagle is a rather light-colored species; its bill is black and its feet are a medium shade of chrome or pale orange, varying to yellow in some specimens. Its plumage is white, cream, pale tan, and different browns; the irides golden yellow.

McGregor has published some interesting notes on specimens of this remarkable eagle.[2]

[1] Philip. Journ. Sci. 15 (1919) 31–55.

[2] Philip. Journ. Sci. § D 13 (1918) 14; 19 (1921) 696.

ILLUSTRATION

PLATE 1. *Pithecophaga jefferyi* Grant, from a photograph of a mounted specimen in the Norwich Museum, Norwich, England.

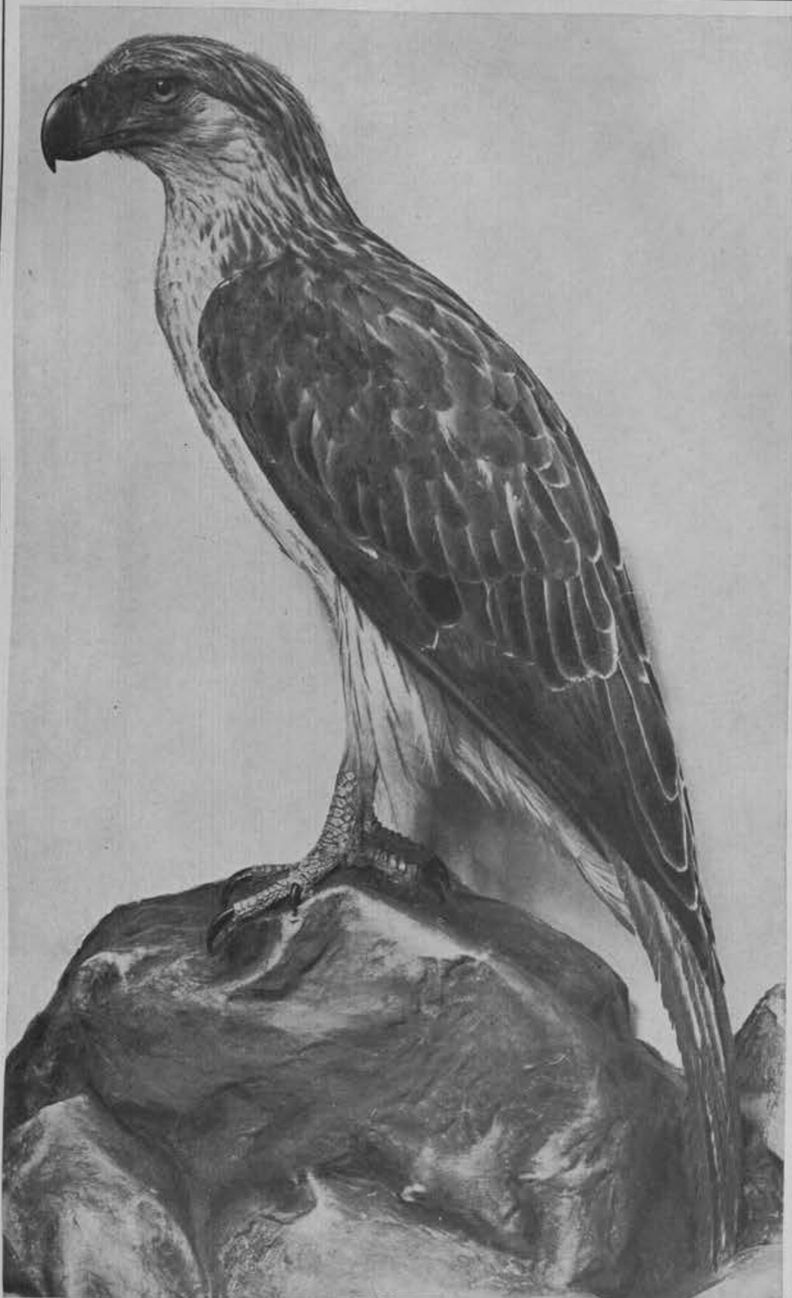


PLATE 1. PITHECOPHAGA JEFFERYI GRANT, FROM A PHOTOGRAPH OF A MOUNTED SPECIMEN IN THE NORWICH MUSEUM, NORWICH, ENGLAND.

THREE NEW SPECIES OF DERBIDÆ (HOMOPTERA)

By F. Muir

Of the Hawaiian Sugar Planters' Experiment Station, Honolulu

FOUR TEXT FIGURES

Zoraida kalshoveni sp. nov. Figs. 1 and 2.

Male.—Length, 3.6 millimeters; tegmen, 10; wing, 1.

Subcosta obscure, lying beneath radius; subcostal cell widened at apex with a round, raised callus in the middle; radial cell very narrow up to callus.

Anal segment large, anus about a third from apex, narrowed slightly on basal half, apex narrowed, truncate; lateral margins of pygofer angularly produced, medioventral margin angularly produced, genital styles long, narrow on basal half, apical half considerably widened, outer margin of apical half curved over, the inner margin with a curved spine about the middle.

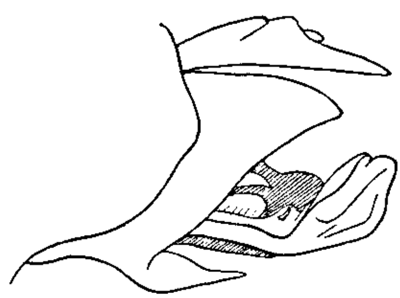


Fig. 1. *Zoraida kalshoveni* sp. nov.; male genitalia, lateral view.

Vertex and face yellow; clypeus light brown, darker between the carinæ; pronotum light on sides, darker in the middle; mesonotum light brown; legs light brown; abdomen brown, yellow near base; genital styles darker. Tegmina hyaline; costal, subcostal, and radial cells red, the callus in apex of radial cell fuscous, shining; a brown band from media to clavus over the basal portion of the fork of cubitus including the apical half of basal cell, the veins in this fuscous area yellow; veins light brown. Wings hyaline, slightly fuscous.

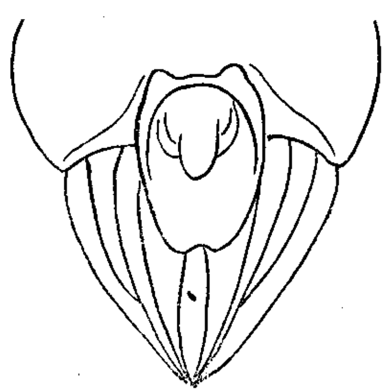


Fig. 2. *Zoraida kalshoveni* sp. nov.; female genitalia, dorsal view.

Female.—Length, 5.3 millimeters; tegmen, 12.3; wing, 1.2.

Pregenital plate angularly produced from sides to middle. Anal segment small, reaching about halfway to apex of styles, sides slightly curved, apex slightly emarginate. In coloration similar to male.

SINGAPORE (*C. F. Baker*), 1 male and 1 female. JAVA, Bodjanegoro (*L. Kalshoven*), 1 female.

Zoraida bakeri sp. nov. Fig. 3.

Female.—Length, 5.3 millimeters; tegmen, 10; wing, 1.

In general build and venation this species is similar to *Z. kalshoveni.*

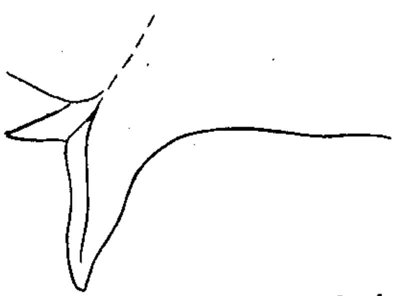


FIG. 3. *Zoraida bakeri* sp. nov.; female pregenital plate, lateral view.

Mesonotum light brown, darker over basal portion. The anal segment is longer, broadest on basal third, gradually narrowed to the truncate apex. The pregenital plate in lateral view turned ventrad at a right angle, in full view the apex is rounded.

BORNEO, Sandakan (*C. F. Baker, 9533*), 1 female.

Zoraida mcgregori sp. nov.

Zoraida sinuosa (Boheman) ? MUIR, Philip. Journ. Sci. § D 12 (1917) 84, Pl. 1, fig. 14.

In the above-cited paper I allowed the Philippine specimens to stand under *sinuosa* until I could examine specimens from West Africa. I have now been able to do this and find that they are quite distinct; so I now name the Philippine species after Mr. R. C. McGregor, of the Bureau of Science, who some time ago forwarded me specimens for identification. The type is a specimen from Malinao, Tayabas, and the paratypes, the specimens mentioned in the previous paper as well as other specimens subsequently received, from the Philippines.

The genitalia have been described and figured previously.

Male.—Length, 4 millimeters; tegmen, 10; wing, 5.

Antennæ longer than face, cylindrical, stramineous or light brown; often white with waxy secretion over mesoscutellum and metanotum and along the middle of dorsum of abdomen; genitalia red. Tegmina hyaline, veins red or brown; fuscous over costal, subcostal, and radial cells in basal median cell,

running into median cells at base of sectors; a faint fuscous mark at apex of apical cells; apical veins brown to apex.

Female.—Length, 4 millimeters; tegmen, 11; wing, 5. Female similar in color to male. The tegmina have a slightly opaque, milky appearance.

Zoraida sinuosa (Boheman). Fig. 4.

I herewith publish a figure of *Zoraida sinuosa* (Boheman) drawn from a specimen from Sierra Leone in the British Museum. A comparison of this figure with the figure cited in the synonymy of the preceding species will show the distinct differences.

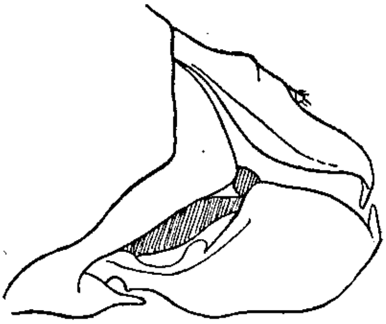


FIG. 4. *Zoraida sinuosa* (Boheman); male genitalia, lateral view.

Zoraida cumulata (Walker).

> *Zoraida insulicola* Kirkaldy, MUIR, Philip. Journ. Sci. § D 12 (1917) 81.

I have examined the type of this species in the British Museum; it is the same as Kirkaldy's species.

Genus **LEUROMETOPON** nomen novum

> *Mindana* MUIR, Philip. Journ. Sci. § D 12 (1917) 94, preoccupied in Coleoptera, Allard, Bull. ou C. R. Soc. Ent. Belg. 33 (1889) CXII.

I have to thank Doctor Bergroth for pointing out that the name *Mindana,* proposed by me in 1917, is preoccupied in Coleoptera. As a substitute for *Mindana* Muir I offer *Leurometopon.*

ILLUSTRATIONS

TEXT FIGURES

PHILIPPINE RICE

By A. H. Wells, F. Agcaoili, and R. T. Feliciano
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Although rice has constituted the chief staple food of the inhabitants of the Philippine Islands for centuries, very little attention and study have been devoted to it, so that the 36,500,000 cavans of palay produced during 1920 might well be regarded as the result of the bounteousness of the soil rather than the product of the efforts of the farmers. However, the peculiar attitude of scientific men and farmers and their apathy toward its study are not confined to the Philippines, but are found in other oriental rice-producing countries as well. This, in part, is responsible for the prevalence of existing primitive methods of rice culture in the Islands; no great use is as yet made of modern implements, fertilizers, and seed selection. Very little attention has been paid to the study of the chemical composition of the kernels, the leaves, the stems, and the roots at various stages of maturity to determine the food value at such different stages, both to men and to domestic animals, and the relations of the variation of these chemical constituents to irrigation, fertilizers, climatic conditions, etc.

The present paper is simply a compilation of the analyses of the kernels of different varieties of rice received in the Bureau of Science from time to time, and is offered in the hope that it may serve to indicate slightly the more important bearings and relations of chemical research to scientific farming.

Of the many varieties of Philippine rice submitted by the Bureau of Agriculture for phosphorus determination, about twenty-three have been also subjected to a general analysis of percentage of moisture, of ether extract, of protein, of crude fiber, and of carbohydrates and starch. For several years these samples have been kept under close observation by the Bureau of Agriculture for variety tests, and in cultivating them efforts have been directed toward making conditions of growth as nearly uniform as possible.[1]

[1] Camus, José S., Rice in the Philippines, Bull. P. I. Bur. Agr. 37 (1921).

TABLE 1.—*Characters of twenty-three awnless varieties of Philippine rice.*

Variety.	Permanent No.	Origin.	Habitat.	Age at maturity.	Yield per hectare.		Degree of popular acceptance.	Physical characteristics of the grain. Shape.	
								Outline.	Thickness.
				Days.	*Kilos.*	*Cavans.*			
1. Roxas No. I	1004	Tarlac	Lowland	142	2,715	63.14	High	Oblanceolate	Medium
2. Cruz	1003	do	do	141	2,857	66.44	Medium	Elliptic	Fairly plump
3. Apostol IV	1001	Laguna	do	144	2,383	55.41	High	Linear oblong	Somewhat thick
4. Conner	1002	Tarlac	do	142	2,644	61.48	Medium	Elliptic	Medium
5. Macan I	527	Zambales	do	180	2,708	63.00	High	do	do
6. Inasimang	447	Tarlac	do	170	2,854	66.25	Medium	do	do
7. Pinilling Daniel	692	do	do	177	2,790	64.48	do	do	do
8. Inantipolo II	956	Cavite	Upland	138	2,378	55.25	High	do	do
9. Dinagat "A" I semi-upland.	362	Laguna	Dual purpose	123	1,904	44.30	Medium	Ovate	Medium
10. Kinandang pute upland	952	Batangas	Upland	106	1,883	43.81	do	Elliptic	do
11. Bad-as	27	Occidental Negros	Lowland	183	2,679	62.25	Medium	Elliptic oblanceolate.	Medium
12. Inachupal	429	Tarlac	do	169	2,624	61.00	do	Elliptic	Thick
13. Jinaloan	469	Occidental Negros	do	183	2,416	56.18	do	Oblong	Plump
14. Jinipon	470		do	170	2,521	58.58	do	Shrimp-shaped	Thin
15. Kinarabao I	486		do	158	2,457	57.10	do	Oblong	Medium
16. Manabaco	578	Antique	do	189	2,536	58.86	do	do	do
17. Manabunac	579	do	do	181	2,536	58.87	High	Elliptic	do
18. Manticanon	598	Tarlac	do	182	2,972	69.12	Medium	do	Thick
19. Molan-ay	629	Antique	do	141	2,399	55.78	do	do	Medium
20. Quinanay	739	Leyte	do	147	1,968	45.76	do	Oblong	do
21. Quinatia I	756	do	do	185	2,866	66.65	do	Elliptic oblong	do
22. Tarbayanon II	860	Misamis	do	144	2,474	57.50	do	do	Thin
23. Virgen	905	Occidental Negros	do	184	2,446	56.83	do	Oblong	Medium

Variety.	Physical characteristics of the grain.								Glutinous (+) or nonglutinous (—).
	Dimensions.		Hispid or glabrous.	Color of—		Thickness of hull.	Color of cuticle.	Flavor.	
	Length.	Width.		Hull.	Tip.				
	mm.	*mm.*							
1. Roxas No. I	8.51	3.16	Hispid	Brown with light stripes.	Straw	Thick	White	Plain	+
2. Cruz	7.81	3.34	do	Straw with purplish shade.	Purplish	Medium	do	Medium	+
3. Apostol IV	8.70	2.98	do	Straw	Straw	do	do	do	+
4. Conner	8.26	3.04	do	do	do	do	do	do	+
5. Macan I	8.05	3.02	do	do	do	do	do	Good	+
6. Inasimang	7.64	3.14	do	do	do	do	do	Medium	+
7. Piniling Daniel	7.83	2.96	do	do	do	do	do	do	+
8. Inantipolo II	7.05	3.05	Glabrous	do	Purplish	do	do	Very good	+
9. Dinagat "A" I semiupland.	7.63	3.01	Hispid	Light straw	Straw	do	do	Medium	+
10. Kinandang pute upland	7.41	3.02	Somewhat hispid	Straw	Light straw	do	do	do	+
11. Bad-as	8.05	3.30	Hispid	Light brown	Light brown	Thick	do	do	—
12. Inachupal	7.70	2.97	do	Straw	Light straw	Medium	do	do	—
13. Jinaloan	8.90	3.75	do	Brown straw	Straw	Thick	Dull white	do	+
14. Jinipon	7.95	2.47	do	do	do	Thin	White	do	—
15. Kinarabao I	9.35	3.75		Straw	do	Thick		do	(?)
16. Manabaco	8.72	2.94	Hispid	Brown straw	Brown	do	Creamy white		+
17. Manabunac	7.24	3.29	do	Straw	Straw	do	White	Good	—
18. Manticanon	7.37	3.17	do	do	do	Thin	do	Medium	—
19. Molan-ay	8.37	3.42	do	Light brownish straw	Purple	do	do	do	—
20. Quinanay	8.95	2.83	do	Straw	Straw	do	do	do	—
21. Quinatia I	7.54	3.13	do	do	do	Medium	do	do	—
22. Tarbayanon II	8.03	2.87	do	Brownish straw	do	Thick	do	do	—
23. Virgen	7.50	2.40	do	Light straw	do	Thin	Amber	do	—

The Philippine Islands, in common with other oriental rice-producing countries, presents a great wealth of varieties which have been classified into groups according to habitat or method of cultivation; namely, upland or lowland rice, awn or awnless, glutinous or nonglutinous. This method of grouping is not strictly scientific; very often there is no definite or distinctive boundary line between several varieties. The designation of a variety as glutinous or nonglutinous, for instance, is not made by a certain definite and arbitrary standard of gluten, above which the sample falls into the glutinous group, and below into the nonglutinous; but, rather, long usage and custom predetermine the class. In some cases the coexistence of certain physical characteristics of the grain places the sample in a certain group. Such physical characteristics include the shape (outline and thickness) of the grain, the length and width of the grain, the color of the hull and tips, the thickness of the hull, the color of the cuticle, the flavor, etc. In Table 1 these different characteristics for the twenty-three varieties under study, together with the origin, habitat, age of maturity, yield per hectare, and degree of popular acceptance are shown.

It is interesting to note from this table that there is a close relationship between the length of maturity and the yield per hectare. The observation is also interesting in that it suggests a method of increasing the yield without expenditure of any special efforts. In general, the late-maturing varieties produce more per hectare than the early-maturing varieties. This fact would seem to be in line with the observations of Chambliss and Adams,[2] who showed that, by allowing the plant a longer time to mature, there resulted "an increase in yield and improvement in quality." Thus, using the same variety for observation these authors found that Wateribune variety gave a yield of 5,350 pounds per acre when allowed to mature in one hundred seventy-four days, and 7,020 pounds in two hundred two days; for Omachi variety, the yield obtained was 5,250 pounds in one hundred seventy-eight days, and 6,730 pounds in two hundred three days. A notable exception, however, is the Carolina Gold, which gave a yield of 4,300 pounds in one hundred eighty-seven days, and only 3,100 pounds in two hundred twelve days; this variety was not acclimatized in California but was grown there only experimentally.

[2] Chambliss, Charles E., and Adams, E. L., Farmers' Bull. U. S. Dept. Agr. 688 (1915).

Such observation, seemingly verified by our table, is suggestive of a method of increasing the yield; that is, it indicates plainly that greater returns could be obtained by simply allowing the crop a longer time in which to mature.

Chemical analysis.—The usual general methods of chemical analysis were followed in this work. All analyses were performed in duplicate to check results; those that did not agree within permissible errors were repeated.

Sampling.—Representative samples were taken from different parts and levels of a 1-kilogram sack of rice, from which the hulls were removed by grinding the kernels in a mortar, utmost care being taken that no polishing was done to the rice grains. Then 100 unbroken kernels were sorted out at random and weighed, the weight representing the weight of 100 kernels of a variety.

METHODS OF ANALYSIS

Moisture.—Moisture was determined by drying a known weight of a sample (2 to 5 grams) in an electric oven at 100° C. until a constant weight was obtained. The loss in weight represents the moisture present.

Ether extract.—Fats were determined by extracting a weighed sample with ether in a Soxhlet apparatus for forty-eight hours; the ether extract was then freed from ether and moisture, and weighed. This result was checked by drying the ether residue and finding the loss in weight.

Protein.—The indirect method of obtaining protein was used. Nitrogen was first determined by Gunning's modification of Kjeldahl's nitrogen determination and then this value was converted by a factor (6.25) into protein.

Crude fiber.—Crude fiber was determined by boiling the residue from the ether extract with 1.25 per cent sulphuric acid for a half hour, then washing it free from acid; the product was again boiled with 1.25 per cent sodium hydroxide for another half hour. The undissolved residue was washed free from alkali, filtered, dried, and weighed. This weight minus the weight of the ash represents the crude fiber.

Ash.—The ash was determined by incinerating carefully the dried sample from the moisture determination. The weight of the whitish or grayish residue, free from carbon, left after careful incineration represents the ash content.

Carbohydrates.—Carbohydrates, starch, etc., other than crude fiber, were obtained by difference.

TABLE 2.—*Results of the analysis of twenty-three varieties of rice cultivated in the Philippines.*

Variety.	Permanent No.	Weight of 100 kernels.	Moisture.	Ether extract.	Protein (N × 6.25)	Crude fiber.	Ash.	Carbohydrates starch, etc., other than fiber (by difference).	Phosphorus pentoxide.	Food value per 100-gram sample.
		Grams.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Calories.*
1. Roxas No. I	1004	2.1790	12.93	1.70	7.88	0.93	1.33	75.23	0.714	356.53
2. Cruz	1003	2.2225	12.10	0.93	8.09	1.21	1.26	76.41	0.695	354.22
3. Apostol IV	1001	1.784	14.53	1.56	8.01	0.88	1.29	73.73	0.766	349.01
4. Conner	1002	2.0285	11.90	2.03	8.14	0.99	1.18	75.76	0.767	362.10
5. Macan I	527	1.6725	12.53	0.83	8.23	1.02	1.49	75.90	0.773	352.25
6. Inasimang	447	1.7200	12.03	0.51	8.10	1.00	1.13	77.23	0.628	354.24
7. Piniling Daniel	692	1.8825	12.02	1.41	7.96	0.95	1.30	76.36	0.729	358.05
8. Inantipolo II	956	1.8850	12.88	1.01	7.83	1.03	0.79	76.46	0.501	354.13
9. Dinagat "A" I semiupland	362	1.9080	12.50	2.29	7.58	1.13	1.15	75.35	0.700	361.22
10. Kinanda pute upland	952	2.2990	13.43	1.87	8.31	1.01	1.19	74.19	0.690	355.24
11. Bal-as	27	2.0370	14.9	3.43	7.00	1.09	1.78	72.89	1.030	359.39
12. Inachupal	429	1.7620	14.15	3.70	8.31	1.00	2.21	71.63	0.980	362.16
13. Jinaloan	469	2.2345	14.6	2.46	8.54	1.18	1.20	72.02	0.706	357.48
14. Jinipon	470	1.8067	14.11	2.71	8.31	1.01	1.19	72.67	0.693	355.34
15. Kinarabao I	486	2.2823	9.96	2.53	7.33	1.35	1.69	77.14	0.837	370.08
16. Manabaco	578	1.7620	13.15	4.14	8.66	1.08	2.03	70.94	0.892	364.22
17. Manabunac	579	1.7968	10.65	3.73	7.66	1.31	1.55	75.10	0.79	374.40
18. Manticanon	598	2.0558	11.05	2.28	7.48	1.32	1.31	77.88	0.81	370.98
19. Malon-ay	629	2.2652	9.62	1.24	7.88	1.76	1.26	80.00	0.71	371.12
20. Quinanay	739	2.0356	11.28	1.36	8.49	1.20	2.88	74.79	0.952	304.29
21. Quinatia I	756	2.0324	10.72	1.07	7.57	2.26	2.14	78.50	0.77	362.52
22. Tarbayanon II	860	1.9056	10.73	1.68	8.09	1.19	0.77	76.56	0.552	366.92
23. Virgen	905	1.8663	10.48	2.23	7.00	1.25	1.23	77.81	0.652	368.63
Average	------	1.9706	12.26	2.03	7.93	1.18	1.45	74.98	0.752	360.63

Table 2 shows the composition of the different varieties examined. Attention is called to the great variation in the percentages of composition of moisture, fats, protein, and carbohydrates; and, as the different varieties were cultivated under identical conditions, these differences in chemical composition must be attributed to variety characteristics.

Energy content.—The food value of the twenty-three varieties expressed in calories gives an average of 360 calories per 100 grams (see Table 2). Assuming the average expenditure of a normal healthy working man to be 3,000[3] calories, daily, he would require about 832 grams a day of Philippine rice to supply this energy.

Table 3 shows the average percentage composition of the samples analyzed compared with rice grown in the United States.[4]

TABLE 3.—*Comparison of chemical composition of Philippine rice with rice grown in the United States, both unpolished.*

	Philippine Islands.	United States.
One hundred kernels .... grams..	1.97	2.46
Moisture .... per cent..	12.26	11.88
Protein .... do.....	7.93	8.02
Ether extract .... do.....	2.03	1.96
Carbohydrates:		
Crude fiber .... do.....	1.18	0.93
Other than crude fiber .... do.....	75.89	76.05
Ash .... do.....	1.45	1.15
Phosphorus pentoxide .... do.....	0.752	0.4(?)

From Table 3 it is seen that Philippine rice compared with rice grown in the United States is poorer in protein matter and carbohydrates (starch, etc., other than crude fiber), but is richer in fats and phosphorus; it also contains more moisture, crude fiber, and inorganic salts. Improvement in the quality of Philippine rice should be made along the line of these deficiencies; that is, toward increase in the protein and carbohydrates. This would seem possible, as indicated by recent investigations by Kelley and Thompson,[5] who have shown that the chemical composition of rice kernels, as well as other parts, is greatly in-

[3] Sherman, Henry C., Chemistry of Food and Nutrition. The Macmillan Company, New York (1911) 155.

[4] Bull. U. S. Dept. Agr., Bur. Chem. 13[9]: 1212.

[5] Kelley, W. P., and Thompson, Alice R., A Study of the Composition of the Rice Plant, Bull. U. S. Dept. Agr. Hawaii Agr. Exp. Sta. 21 (1910).

fluenced by several factors; namely, climatic conditions during plant growth, seasonal variation, type of soil, and nature of fertilizers used. All other factors being identical the effect of seasonal variation alone on the composition of the grain is shown in Table 4.

TABLE 4.—*The effect of seasonal variations in the water-free composition of grain at maturity.*

	Spring crop.	Fall crop.
	Per cent.	*Per cent.*
Nitrogen	1.24	1.22
Potash	0.41	0.39
Phosphoric acid	0.92	0.83
Carbohydrates	83.80	80.29

As the seasonal variation in this country is very slight throughout the year, its effect can be practically eliminated from consideration. This would seem to suggest that the problem of improving the quality of rice resolves itself into a proper control of fertilizers, methods of cultivation, and irrigation. The effects of different fertilizers on the rice composition can be seen from Table 5.

TABLE 5.—*Water-free composition at maturity of grain.*

Composition.	Check Plate I.	Mineral Plate II.	Nitrogen Plate III.	Complete fertilizer IV.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Nitrogen	1.36	1.36	1.31	1.24
Potash	0.39	0.44	0.42	0.41
Phosphoric acid	0.98	0.92	0.89	0.92
Lime	0.02			0.02
Magnesia	0.27			0.25
Carbohydrates	79.66	80.97	83.52	83.80

Thus, by the use of a complete fertilizer, the carbohydrate content has been improved from 79.66 per cent to 83.80 per cent, an increase of 4.14 per cent, this at the expense of protein matter, as the table shows. However, in the mineral plate, the nitrogen content remains the same, while the carbohydrates have been increased. It is possible, by the use of proper proportions of the ingredients in the fertilizer, to increase both the carbohydrate and the protein contents.

SUMMARY

1. The scientific control of fertilizers, cultural methods, irrigation, etc., are very important factors in improving the yield and the quality of rice; the simple expedient of allowing the rice a longer time in which to mature will undoubtedly be beneficial.

2. Philippine rice compares very favorably with rice grown in the United States.

3. Improvement in quality should be directed to increasing the percentage of protein and carbohydrate contents.

THE FOOD VALUE OF PHILIPPINE BANANAS

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INTRODUCTION

One of the well-known and most-important fruits throughout the Philippine Archipelago is the banana. It is highly esteemed by rich and poor alike, since it is not only economical but also wholesome, delicious, and very appetizing. Furthermore, it is the most plentiful of the Philippine fruits, being found at all times in the Philippine markets. Therefore, this fruit is very popular. Although it has long been an important article of our diet, no practical systematic work has been carried out in studying its chemical composition, and consequently we do not know definitely to what extent and in what way Philippine bananas aid the human system.

There are some interesting features of the bananas that are worthy of note. The fruit can be preserved in many ways without deterioration, and it can be shipped easily from one place to another. The suckers are well suited for transport over long distances without injury. The plant grows in a great variety of soils and under widely varying conditions. Unfortunately, Philippine bananas do not receive any kind of cultivation, being planted usually about dwelling houses for immediate consumption. If given the right scientific treatment and culture the commercial and food values of Philippine bananas can hardly be overestimated.

There are many varieties of Philippine bananas, each of which has distinct characteristic taste and flavor. Some are somewhat acid, and others are sweet. Of some varieties the fruits are eaten raw, while those of others, like the saba, must be cooked first to make them more palatable. In the best varieties the pulp is soft and has a pleasing, delicate flavor. The bananas treated of in this paper are the common ones that Filipinos use constantly as food.[1] They are greatly appreciated by both Filipinos and foreigners.

[1] For botanical descriptions and illustrations of Philippine bananas see Philip. Journ. Sci. § C 10 (1915) 384, and Philip. Agr. Rev. 12 No. 3 (1919).

TABLE 1.—*Data of analyses of the fruits of twelve varieties of Philippine bananas.*

Scientific name.	Local name.	Average weight of one fruit.	Skin.	Edible portion.	Water.	Ether extract.	Protein (N × 6.25).	Sugars.		Starch and other carbohydrates (by difference).	Crude fiber.	Ash.	Acidity as sulphuric acid.	Calorific value per 100 grams of food.
								Sucrose.	Reducing.					
		g.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Calories.*
Musa sapientum var. *ternatensis* (Blanco) Teodoro.	Gloria, ternate	95.8	38.9	61.1	66.56	0.69	1.07	2.03	25.0	3.41	0.31	0.93	0.34	136.9
Musa sapientum var. *compressa* (Blanco) Teodoro.	Saba	50.7	39.0	61.0	69.16	0.71	0.93	4.86	17.20	5.85	0.28	1.01	0.64	126.0
Musa sapientum var. *cinerea* (Blanco) Teodoro.	Latundan, letondal.	62.7	25.8	74.2	70.19	0.63	1.59	0.94	22.72	2.43	0.53	0.97	0.44	121.5
Musa sapientum var. *suaveolens* (Blanco) Teodoro.	Buñgulan	135.0	31.8	68.2	71.17	0.74	1.33	7.89	16.89	0.72	0.44	0.82	0.28	118.7
Musa sapientum var. *lacatan* (Blanco) Teodoro.	Lacatan	72.4	23.6	76.4	70.96	0.67	1.61	16.33	7.46	1.55	0.38	1.04	0.31	118.3
Musa sapientum var. *grandis* Teodoro.	Sabang Iloco	261.0	40.8	59.2	70.59	0.28	1.49	0.23	19.23	6.73	0.48	0.97	0.40	118.1
Musa sapientum var. *inarnibal* Teodoro.	Inarnibal	34.9	25.7	74.3	72.87	0.66	1.68	15.00	6.41	1.93	0.52	0.93	0.33	110.8
Musa sapientum var. *violacea* (Blanco) Teodoro.	Morado	71.9	38.0	62.0	73.35	0.57	1.47	17.73	4.27	1.15	0.58	0.88	0.29	108.6
Musa sapientum var. *principe* Quisumbing.	Principe	99.0	42.7	57.3	73.69	0.41	1.42	16.95	4.09	2.06	0.61	0.77	0.30	106.9
Musa paradisiaca var. *magna* (Blanco) Teodoro.	Tundoc, tondoc	446.5	16.0	84.0	68.66	0.80	1.48	1.33	22.73	3.49	0.35	1.16	0.53	127.9
Musa paradisiaca var. *maxima* (Blanco) Teodoro.	Matavia, batavia	181.2	45.3	54.7	69.97	0.59	1.03	3.16	18.52	5.49	0.32	0.92	0.54	122.4
Musa errans var. *botoan* Teodoro	Butuhan, butuan	104.4	41.3	58.7	83.08	0.40	1.01	0.15	10.75	3.03	0.50	1.08	0.22	67.0

METHODS OF ANALYSIS [2]

In analyzing these fruits eight determinations were made; namely, water, ether extract, protein, sucrose, reducing sugars, crude fiber, ash, and total acidity. The average weight of the fruit and the percentages of the edible and waste portions were taken. Ripe fruits in sound condition were used in the analyses. The edible and waste portions were carefully separated and the former ground in a mortar until uniform representative samples could be obtained.

Sulphuric acid was adopted as the term for the expression of acidity because of its convenience in allowing comparison. Besides, I found that the acidity of the banana is due to the mixture of butyric and citric acids. Furthermore, a part of the acidity may be due to the presence of acid salts, so that an attempt to express the total acidity in terms of a single organic acid characteristic of the fruit would obviously meet with difficulties. Sulphuric acid has already been adopted by a number of laboratories for similar work, and it is accepted here as offering the most satisfactory basis for the expression of acidity in this fruit.

FUEL VALUE

In order to express the capacity of the banana for yielding heat or energy to the body the term fuel value is here used. By the fuel value of a food is meant the amount of heat, expressed in calories, equivalent to the energy which we assume the body could obtain from a given weight of that food material if all of its nutrients were thoroughly digested, a calorie being the amount of heat required to raise a kilogram of water 1° C. This definition applies to what is known as the large calorie, which is one thousand times as large as the small calorie. The fuel value then of this fruit is calculated by means of the factors of Rubner, in accordance with which the amount of energy in 1 gram of each of the three principal classes of nutrients are: For carbohydrates, 4.1; for protein, 4.1; and for fats, 9.3.

Table 1 shows the results of analyses of twelve varieties of Philippine bananas.

CONCLUSION

The components that make up the edible portion of the Philippine banana include water, fat, protein, carbohydrates, organic acids, and mineral matter. Of these water is hardly to

[2] The methods of analysis used are in accordance with Bull. U. S. Bur. Chem. 107 rev. ed. (1908).

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